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THE BUSINESS SITUATION IN REVIEW.

By Newton Sharp.

TO obtain the best possible insight into present conditions of trade and finance, and to obtain the most accurate estimate of the future, it is necessary to examine all of the many factors contributing to their development. A review of the past and an outlook into the future disclose many points that are good, some that are doubtful, and a few that are distinctly unfavorable. It is cheering, however, to be able to declare that at the present time the factors working for good outnumber by far those which may be viewed with concern, and the trend of the doubtful ones is also favorable. It must be remembered, however, that, before we can attain a high level of prosperity, there are many matters to be adjusted; others which must pass from a state of doubt to one of certainty; and still others which must be corrected by human energy and ability. The period of depression through which the country has passed is too fresh in men's memory to enable them to proceed with decision and confidence. But credit is being restored, and confidence is growing everywhere. That is the chief and most important change in the situation. It only remains that their growth should be unchecked for the improvement begun this year to lead to a degree of prosperity to which the country has been a stranger for more than a decade.

It is necessary to revert to the execution of the bond contract between the secretary of the treasury and the Morgan-Belmont syndicate in order to attain a clear view of the situation. It is evident that the remarkable change which followed the making of that contract was due, primarily, to the restoration of confidence in the stability of the

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government finances, and it is to be noted that it was not until the adjournment of congress that the stock market, which is always first to reflect an approaching change in conditions, began the wonderful advance which apparently has as yet by no means culminated. That the improvement in securities was due almost entirely to restored confidence and credit is clearly shown by the fact that at that time there was almost nothing else to justify an advance in the market. Business was at its lowest depth of depression, and showed scarcely a sign of recovery ; railroad earnings showed constant and heavy decreases, with no apparent chance of improvement. It was idle to talk about the crops at that time, not only on account of the season, but because the low prices obtaining for all of the country's staple products tended to induce farmers to plant as little as possible. Since that time innumerable developments have taken place, which not only justify the course of the stock market, but which, if continued along their present lines, would also justify a greater augmentation of values. An estimate of the probable course of stock prices, to be correct, must also be an estimate of those matters which determine the prosperity of the country. The revival of credit and confidence has found a wonderful reflection, not only in the value of securities, but in a revival of trade ; and it is not too much to say that the rise in the prices of staple products and of metals may to a great extent be referred to the same cause.

Those matters, then, about which as definite information as possible must be obtained are as follows : first, the crops ; then the general trade situation as it is, and its probable development and expansion. Our foreign trade relations as reflected in the rates of exchange must be duly considered ; the re-organization and the management of our great semi-public corporations must be taken into account ; and, last of all, the political outlook needs to be carefully weighed. Definite knowledge of the crops should be had certainly within the next 15 days. So much depends on an at least fair harvest that it would perhaps be wise to postpone a consideration of the present and future state of trade and finance until exact information is had concerning it ; but at this time the cheerful crop outlook is one of the distinctly favorable features of the situation, and it ought to be remembered that, even admitting a somewhat smaller yield of wheat and cotton than last year, the higher prices the country will obtain for both of these staples will more than offset the loss to the country at large through the decreased yields.

The Government crop report published on the 10th of August showed conditions such as had been generally expected, except that the percentage for cotton, 77.9, was considerably below speculative calculations. The showing for corn and wheat was about what had been expected. Estimates based on those figures indicate the enor-

mous yield of about 2,390,000,000 bu. of corn. The wheat yield, including both spring and winter crops, was estimated from the showing at 396,000,000 bu., of which the spring crop will furnish about 168,000,000 bu. The low percentage for cotton as indicated in the report sets forth a yield of about 7,500,000 bales.

Ever since the formation of the bond syndicate sterling exchange has ruled at rates which, during the past few years, have been coincident with heavy shipments of gold to Europe. This tendency has been interrupted only once, and then for a brief time. Our position as a debtor country is familiar to every thinker. It would be difficult to estimate the debt of this country to Europe, representing foreign capital invested here in railroads, innumerable corporations of other kinds, municipal securities, business, and the open money market. The foreign exchanges at a given time represent the difference between a normally favorable trade balance on the one hand, and, on the other, the settlement of the interest, dividends, and profits on our foreign debt, and such other obligations as tourists' expenses and freight charges. Broadly speaking, then, an export or import movement of gold reflects the inward or outward flow of foreign capital. Prior to the formation of the bond contract, there was a constant withdrawal of foreign capital and a steady liquidation of securities owned by foreigners which threatened an almost immediate suspension of gold payments by the United States government. Since that time, while this process, in bulk, has been no longer continued, the situation has been but little relieved by foreign capital, and Europe has shown little other favorable interest in our securities than that undertaken on the bull side of the stock market. As it seems probable that the country will have a smaller available surplus of wheat and cotton for export than usual, it would appear that no relief can come to the exchange market other than from a revival of European confidence in our securities.

Several banking and commercial houses not included in the syndicate or obligated by its provisions have, since the middle of July, been shippers of gold either in settlement of their foreign obligations or to make the profit possible through selling bills at the prevailing rates and shipping the actual gold against their sales. It is understood that the syndicate members will not themselves ship gold during the life of the bond contract. By assumption the contract runs until October 1. The backward condition of the grain and cotton crops results in a diminished supply of the usual features of exchange, and, beyond the purchases from time to time of gilt-edged bonds, the exchange market has not been relieved by European takings of our securities. At this writing the shipments of gold on this movement aggregate about $14,000,000. Of this amount the treasury has lost

all except about $500,000. Out of their surplus holdings collected at the formation of the syndicate and since, the syndicate managers have reimbursed the treasury about 50 per cent. of the loss through the gold shipments. The question of a further strengthening of the gold reserve through another issue of bonds is not an imminent one. At the same time, as long as the government revenues run behind the expenditures, as at present, and as long as the government remains in the position of a quasi bank without the powers of a bank, the foreign exchanges will be a disturbing factor.

This distrust seems to be referable to two matters: First, the political outlook, as viewed from a foreign standpoint; and, second, the reckless mismanagement of our corporations, which has resulted in the periodic, partial, or complete collapses of companies like the Atchison, the Erie, the Northern Pacific, the Reading, the Union Pacific, and the Norfolk & Western, in all of which companies European capital is largely involved. The bankruptcies of these companies, deplorable in themselves, have served to direct foreign attention to the manner in which our great corporations are mismanaged,—a mild term for the policy which allows some minor subordinate officials to precipitate and conduct wars of rates, simply that they may be able to return to the board of directors superficially favorable traffic returns. In any other line of business a man who conducted his business at a constant loss would be called a fool, and would be taken charge of by his friends; yet, to put the matter in a homely way, that is just what a large number of the railroad companies of the country are doing at the present time, and the same policy appears to be in favor among another group of corporations of tremendous influence,—namely, the anthracite coal producing and carrying railroads. Foreign advices and newspapers show that public opinion abroad is thoroughly roused on this subject, and it is idle to expect a renewal of European interest in our securities until an end is put to this discreditable business.

The political outlook, however, is assuming a more favorable turn. The action of the new congress on the currency and silver questions will have a powerful influence on foreign sentiment,—an influence so powerful, in fact, that it may enable the country to take strides ahead which will make such measure of improvement as it has enjoyed seem trifling. Hard work is being done, both by the advocates of sound currency and the heretics. The battle seems to be on the side of the just.

In taking up the general business situation and its outlook, we find that, as in the financial situation also, there are signs of various and varying kinds, but that the drift is towards betterment. At the present time the only unfavorable features are those which might be explained

away on account of the season of the year, or which are the result of apprehensions concerning either legislative possibilities or questions affecting the currency. The tariff revision of 1893 taught this generation a lesson of which many were entirely ignorant,—that, regardless of the equities of the changes made, a derangement of business is almost certain to accompany the process of effecting those changes. Since the next congress will not be in sympathy with the executive of the nation, we shall probably enjoy a relief from further meddling with the tariff, and all that business requires is to be let alone. The political complexion of congress makes it quite certain that no extreme changes will be made in our currency system. For these reasons business and finance seem assured of a comparatively long period of freedom from legislative interference, and discussion concerning them may proceed without taking undue account of their influence.

By far the most important and significant feature in the general situation is furnished by the wonderful revival in the iron and steel trade. The advance, which began in pig iron, has now spread to all the forms in which iron and steel are manufactured for use, and the general advances are sustained by an activity which is only interrupted as is the rising tide, each wave, on receding, being followed by another that breaks further up the beach. The most careful calculations can detect no material set-back to the growth of these industries for more than a year, and that this fact is appreciated by the largest manufacturers is shown by their willingness to place large orders, the fulfilment of which extends far into 1896. On the whole, the amount of business sustains a remarkable volume considering the heavy production, both of those mills which continued in operation during the business depression and of the many that have started up since. The orders for steel rails, for instance, for the first half of the year, aggregate 713,000 tons, against 502,000 tons for the same period of last year,—an increase of over 40 per cent. The same ratio of gain is seen in many other industries. As was so ably pointed out by Mr. Edward Atkinson in his article entitled "The Signs of the Times" in the August number of this magazine, few people yet comprehend that the iron and steel industry of this country is undergoing a wonderful transition, and one, it is safe to say, that involves the ultimate transfer of the paramount control of the production of iron and steel from Europe to this country. Mr. Atkinson estimated that during the next 5 years there will probably be at least 30,000 miles of railroad constructed in this country. When it is considered that, in addition to this, the present mileage, which amounts to 180,000, stands largely in need of repair and new equipment, it is difficult to see anything else than a most prolonged period of activity ahead, both for iron and steel, and, indeed, for all of the forms in which iron

is used. The measure of advance already attained, both in the crude and manufactured articles, has raised fears in some quarters that prices will attain a figure at which our mills will be brought into competition with those of England, and for that reason some critics deprecate any further advance from the present level of prices. We are not able to sympathize with this view. Unless the sober estimates prepared by Mr. Atkinson and collated from other sources are at fault, there is business enough in sight for everybody, and, as the present revival cannot be expected to continue indefinitely, it will be just as well if some part of the tremendous prospective demand should be filled from abroad. Otherwise, in so far as the enormous demand may be somewhat spasmodic, it will only lead to the construction in this country of unnecessary plants, which later might find themselves unemployed when the next ebb tide of industry sets in. Observers all recognize that there are tides in trade as there are in the ocean ; the important fact to be recognized is that the tide has now turned, and is making for the flood level.

The figures presented by the bank clearances for July are distinctly encouraging, and not less so because of the fact that perhaps some branches of trade contributed rather disproportionately to the total, since there is no more favorable feature of the general situation than that the spirit of improvement has spread from one line into another, lifting them all out of stagnation and leaving them on a better and healthier basis. The average increase in clearances for July was 29.8 per cent., whereas the average for the whole year was only 16.1 per cent. Outside of New York the totals for the same periods were 21.7 per cent. and 10.3 per cent. It is to be remembered also that the month of July was not one of active speculation either in the stock or the cotton markets of New York.

As showing the steady decline in business activity during the years 1893–94, and the strong recovery of 1895, the following detailed record of clearing-house exchanges is full of significance :

	MAY.		
	1893.	1894.	1895.
Boston	432,500,000	352,600,000	417,145,000
New York	3,055,500,000	2,093,100,000	2,833,846,000
Philadelphia	328,150,000	256,500,000	297,800,000
Baltimore	63,700,000	59,500,000	58,100,000
New Orleans	41,800,000	32,600,000	36,000,000
St. Louis	109,150,000	98,000,000	113,600,000
Chicago	461,100,000	378,500,000	430,100,000
Cleveland	25,600,000	19,400,000	23,800,000
Pittsburg	66,800,000	57,400,000	64.700,000
Omaha	29,500,000	21,800,000	14,400,000
Kansas City	49,600,000	40,000,000	45,100,000
San Francisco	69,700,000	60,100,000	54,600,000

JUNE.

	1893.	1894.	1895.
Boston	367,900,000	327,100,000	387,900,000
New York	2,625,900,000	1,898,600,000	2,480,900,000
Philadelphia	305,100,000	242,600,000	305,800,000
Baltimore	63,900,000	56,500,000	59,800,000
New Orleans	33,700,000	28,000,000	31,800,000
St. Louis	95,300,000	91,300,000	101,700,000
Chicago	377,500,000	357,900,000	385,000,000
Cleveland	23,900,000	20,900,000	23,900,000
Pittsburg	57,900,000	55,400,000	62,900,000
Omaha	26,400,000	22,900,000	13,600,000
Kansas City	40,400,000	37,600,000	42,300,000
San Francisco	57,400,000	51,200,000	59,300,000

JULY.

	1893.	1894.	1895.
Boston	374,200,000	332,000,000	448,400,000
New York	2,393,400,000	1,843,400,000	2,527,300,000
Philadelphia	280,700,000	250,200,000	305,300,000
Baltimore	60,850,000	60,600,000	64,000,000
New Orleans	27,500,000	27,400,000	29,200,000
St. Louis	82,600,000	87,500,000	103,400,000
Chicago	350,700,000	323,100,000	403,400,000
Cleveland	22,900,000	20,700,000	28,300,000
Pittsburg	51,200,000	57,400,000	69,800,000
Omaha	22,300,000	19,100,000	14,300,000
Kansas City	27,400,000	36,000,000	41,300,000
San Francisco	49,900,000	45,600,000	58,900,000

The inevitable conclusion remains that, allowing for the period of crop uncertainty, there is an improvement which has come to stay. It is an aphorism that business creates other business, just as a contraction in any one line is reflected through all others. Taking the least enthusiastic view of the outlook, only the wilfully perverse will take any but a conservatively hopeful view of the country's future.

The object of this article has been to take a conservative view of the situation as it is and of the future as it will probably develop. We repeat that the corner-stone of the change in the average condition of the country during this year has been the restoration of credit. It is clear that unwise legislation or a turn in the political situation, which, fortunately, there is now little reason to fear, may undo all that has been already accomplished. The era is distinctly one of regeneration; the building and re-building noticeable in all lines of trade and finance are simply the result of revived credit and confidence. They are in the sharpest contrast to the failures, corporate bankruptcies, and general disintegration of the past few years. We believe that, however tiresome the reiteration of the idea may be, the future depends on the common sense of the country,—its common sense commercially, financially, and politically. These matters are not to be considered apart, and it behooves every individual to use his personal influence with his neighbor in the line of proper thought.

THE EMANCIPATION OF LABOR BY MACHINERY.

By A. E. Outerbridge, Jr.

WHEN Adam Smith published in 1776 "The Wealth of Nations," a book which is still regarded as a sort of gospel of political economy, the education, environment, and general condition of the laboring classes was radically different from those of the present day. Very many of the most important trades and professions were not then in existence, and the educational influence of machinery had scarcely more than touched the intellect of the artisan with its quickening impulse. Yet we find that modern writers continue to apply the creed of Adam Smith to social conditions of to-day, which are as far removed from those existing in England a century ago as the present civilization of the United States is in advance of that of China.

A student of industrial sociology who approaches the study of the mutual relations of employer and employee, having the advantage of some practical experience in the workshop and of daily contact with workingmen engaged in mechanical or other occupations requiring skill, is impressed with the fact that the best-known authors—those whose tenets are the most universally accepted—have been, as a rule, college professors and scholastics whose knowledge and intellectual acumen, though profound, are altogether theoretical. Such writers are prone to formulate theories which too often have but scant foundation in fact, and reveal the lack of personal experience from the operative's standpoint; they are apt to accept dogmas of their predecessors without question, and thus they continue to promulgate obsolete fallacies.

The doctrines of social economics are not to be accepted on faith, nor are they founded on faith; and they are necessarily subject to continual revision in order to adapt them to changing conditions.

In Adam Smith's day the proportion of operatives who were intellectually in touch with current events, beyond the mere routine of "days' work" and narrow sphere of daily existence, was infinitesimally small. At the present time the general diffusion of knowledge, through free education in the public schools, the wonderful digest of the world's events in the daily papers, and the general dissemination of elementary science by cheap magazines, has percolated down to almost the lowest stratum of the wage-earning class. The affairs of the

nations are intelligently discussed at dinner-time, in the lodge, and wherever workingmen congregate.*

In great political crises the wage-earners in this country form a "court of last appeal," in which the intelligent jury may, as a rule, be depended upon to decide important questions in a thoroughly comprehensive manner

Those who were privileged to listen to a farewell address on "Social Conditions in England," delivered in Philadelphia last spring by Professor W. Hudson Shaw, of Balliol College, Oxford, who has been lecturing during the past two winters in this country in the University Extension Course, obtained much valuable, though painful, information regarding a condition of labor-unrest in England, which presents strong points of contrast to the intellectual, social, moral, and physical condition of the working-people of this country.

In the course of this address the speaker exhibited a book called "Merrie England," written by a journalist named Robert Blatchford, regarding which the following remarkable statement was made, the quotation being given from memory; "Before I left England 600,000 copies of this book were sold, and before I return I believe that a million copies will have been sold to working-people. Each copy has been carefully studied by not less than five persons, and we thus estimate that five million working-people have now read and accepted the doctrines of Robert Blatchford. Yet the ruling classes of England to-day are so far from being in touch with the state of things as they exist among the masses that they know nothing of this movement, which is destined to create vast changes in the complexion of social and political affairs in England in the near future. Lord Rosebery, until a recent period, had not even heard of this book."

Since Prof. Shaw's return to England, Lord Rosebery's administration has been overthrown, and the statement has been noticed in print that more than a million copies of "Merrie England" have been sold, the present price of the book being one penny!

Curiosity induced me to purchase a copy of this book, then unknown in America, though it has recently found its way across the water and is reprinted in cheap form for popular distribution. It is remarkable for its vigorous style, being often dramatic, but it is calculated to do much harm to the workingman, though, fortunately, the social condition of the wage-earning class in this country is not such as to nourish such seeds of discontent.

* "The educational influence upon the operative of daily contact with machinery is, in my judgment, a potent one, enlarging his mental horizon, giving him more accurate perceptions of the true relations of parts and fitness of things, and elevating him intellectually above the average plane of the former handicraftsman."—"The Educational Influence of Machinery." ENGINEERING MAGAZINE, May, 1895.

It consists of a series of letters addressed to a supposititious "John Smith," a weaver of Oldham, who is taken as the representative of the working-class in England. The utter hopelessness and misery, depicted in these letters, of the workingman's life in that country cannot fail, whether true or false, to arouse the slumbering fires of discontent in the minds of those to whom the letters are addressed. "The factory system," "the private ownership of land," "the capitalistic press," "the parliament of landlords," and other "wrongs" too numerous to mention are inveighed against in powerful language.

Then, by way of contrast, a socialistic Utopia is pictured to the weaver's bewildered brain, in which beautiful fields, woods, gardens, cattle, streams, birds, and flowers abound, and the writer says: "You know that all these things are well worth having, and that none of them exist side by side with the factory system. . . . I despise the factory system, and denounce it as a hideous, futile, and false thing. . . . . Rent, interest, private ownership, machinery, and competition are all instruments in the hands of the capitalist, and with those instruments he compels the worker to give up nearly all his earnings in return for permission to work."

Here we have the whole economic teaching of the book embodied in a few sentences: the capitalists—that is to say, the employers—are robbers; the factory and the machinery in it are mere instruments of robbery; and the only means of escape for the wage-earners is to vote for the socialistic ideal, wherein the State would be the sole proprietor and employer. The effects of such teaching are seen plainly in the pronounced socialistic organization and tendency of the London county council; in the dogged opposition of the English trades unions to the introduction of improved machinery and improved methods of production; and in Mr. Herbert Spencer's recent cabled declaration that he regarded "the advent of socialism as the greatest calamity that has ever befallen the human race." In a word, as the result of false teaching, the industrial population of England seems to be setting its face squarely against progress.

It is now admitted that the introduction of machinery has proved beneficial to the wage-earning class, and the fear that the substitution of machinery for human toil would prove disastrous to wage-workers has been disproved. Yet, in spite of this, no longer ago than 1877 the University of Cambridge, England, awarded the "Cobden prize" (£60) to J. S. Nicholson, B. A., for an essay on "The Effects of Machinery on Wages," in which the author italicizes the phrase, "Machinery of itself does not tend to develop the mind," and again says: "It is clear that the use of machines, though apparently labor-

saving, often leads to an increase in the quantity of labor; negatively by not developing the mind, positively by doing harm to the body." Further, he quotes John Stuart Mill to the effect that "labor-saving inventions have not lightened the toil of any human being; they have only enabled a greater number to live the same life of drudgery and imprisonment." These references are given, not for the purpose of argument, but to show that scholarly writers often fail, through lack of practical knowledge, to perceive facts as they really exist.

Costly experiments have been made in the mining regions of Pennsylvania, and in some large industrial works in this country, during the past score of years, in the introduction of foreign "pauper labor," but I believe that the universal experience has been, at least in manufacturing industries, that ignorance is the most expensive element that can be introduced in the modern complex manufacturing system, and intelligence is again receiving due recognition. Several large steel and iron makers, bridge constructors, and others have testified that the result of this pauper labor experiment has proved that the comparatively high-priced, intelligent labor of English-speaking operatives is, in the end, far more economical than that of Huns, Poles, and other semi-civilized people who emigrated to this country in vast hordes some years ago for the purpose of supplanting native labor at low wages. The old adage that "main strength and stupidity" comprise the working capital of the average workingman is no longer applicable, for the operative is not regarded as a mere machine, but as an intelligent being, whose business it is to control machines.

Not only did the cost of errors in work and injury to machinery which were traced to the ignorance and stupidity of the pauper labor element outbalance the difference in wages paid formerly to educated workmen, but the labor strikes, lawlessness, and crime of all kinds, beginning with the "Molly Maguire" reign of terror in the coal regions, were due largely to this foreign importation. The intervening periods of depression in manufacturing have resulted in a general exodus of this disturbing element, and it is not likely that employers will again attempt to evade the contract-labor laws by subterfuges such as were believed to have been formerly adopted. The recent voluntary action of employers in raising wages is encouraging, not only as an evidence of returning prosperity, but as indicating a growing appreciation on their part of the economy of fair wages and intelligent service as compared with poor wages and ignorant labor.

The emancipation of labor by machinery may now be conveniently considered under the following heads:

1. Amelioration of exhausting toil.
2. Intellectual and social elevation of wage-earners.

3. The influence of machinery on the future relations of capital and labor.

The examples which might be given to illustrate the first proposition are so numerous and self-evident that the reader may readily supply a long list from personal observation. One of the interesting proofs of the lightening of toil by the aid of machinery is found in the constantly enlarging sphere of labor being opened to self supporting women, and the prediction is here made that within the next quarter of a century the ranks of the mechanic will be largely augmented by women. Already many of the newer industries, such as the manufacture of incandescent electric lamps, are practically in the hands of women. In every field where women have entered they have proved themselves apt scholars and expert workers, so that the prejudice which formerly excluded them from many trades is fast dying out. No more convincing proof that "main strength and stupidity" are giving way to manual dexterity and mental activity as the working capital of the wage-earner could be adduced than this.*

The once familiar outcry that the sewing machine would deprive the poor seamstress of her means of subsistence, and that it was therefore "a criminal invention," still lingers as a memory in the minds of many who have lived to see far different practical results therefrom.

Statistics show that the number of women to whom the sewing machine gives occupation to-day is vastly greater than the number who formerly gained a precarious livelihood with the needle, or who could obtain similar work now under old conditions.

Contrast the "work-a-day" clothes and simply-made "Sunday-go-to-meetin'" garments of the people of a century ago with the wonderful variety and complexity of finery comprising the holiday attire, and, indeed, the every-day wearing apparel, of those of a similar class to-day. If it is true, as stated, that one sewing machine operated by one woman will do the work of ten hand-sewers, it is no less true that the modern woman possesses ten times as many garments as her sister of a former age, and each garment displays ten times as much machine-sewed work upon it.

If you examine the quaint hand-made costumes of dames of high degree of the revolutionary period, which are carefully preserved in glass cases in old "Independence Hall" in Philadelphia, you will see that this statement is literally true. We have thus shown an enormous actual increase of sewing work *per capita*, rendered possible by the machine.

If we should extend this inquiry farther, we would perceive a still

*According to the last census, the number of women, engaged in various trades and occupations in the United States increased during the decade 1880–1890 over 250 per cent.

wider opening of the doors of labor to women through the sewing machine; in textile decoration and in almost every department of household art and luxury we can trace its influence.

The sewing woman has reaped the benefit of this expansion of opportunity for remunerative employment and improvement of methods of work; the plaintive "Song of the Shirt" has not such general application as of old; the pathos of self-sacrificing labor, often continued into the small hours of the night, has been in large measure relieved by organization of such labor under proper regulations; so that (excepting the criminal "sweat-shop system," conducted by foreigners in cellars and obscure tenements) the sewing machine has conferred vast benefits upon the very class whom it was supposed it would most disastrously affect, while the number of men employed in the manufacture of sewing machines constitutes a vast army.

But the sewing machine is a mere suggestion. The mind is fairly staggered in contemplation of the wealth of opportunity for wage-earners that has been created by the steam engine,—especially in the form of the steamship and locomotive, which have literally opened new worlds to the old world's poor. And what is true of the steam engine is true only in lesser degree of the telegraph, the telephone, the electric motor, the turbine, and the whole range of modern agricultural machinery.

The modern bicycle—a theoretically perfect invention, and, in some respects, an almost perfect mechanism—has already produced beneficial effects upon the physical development of the wage-earning class sufficiently marked to attract general notice, and its future influence is incalculable. It is destined, in my judgment, to emancipate woman from many of the conventional shackles which have bound her for ages, and from some physical disabilities which have hitherto limited her sphere of occupation. This is only one of the many striking instances in which invention is helping to benefit the masses.

I am convinced that modern mechanical inventions have in all cases proved to be distinctively beneficial to the wage-earner. He is through their aid better housed, better fed, better clothed, better educated, has more numerous and better amusements, and is thus approaching more nearly the condition of life of the employer; indeed, the wage earner to-day enjoys many advantages of civilization which were unknown to the employer of a generation gone by.

The majority of employers in this country are men who have risen from the ranks, and many of our most important inventions have been made by wage-earners, who have the best opportunity, through experience in their daily work, to learn the necessities of the age.

In Europe the mechanic belongs to the "second class," and in

England even the professional man, unless gifted with exceptional ability and renown, is on a social plane inferior to that of the titled idler. In America wage-earners possess distinct advantages over those of Europe in that "class distinction" is not tolerated, and the few attempts to arbitrarily separate individuals into classes, irrespective of personal qualifications, in imitation of foreign aristocratic ideas, have only succeeded in bringing ridicule upon the authors. But in Europe the lines are so sharply drawn that it is far more difficult for merit to obtain the recognition which is so freely accorded in America and to which this country so largely owes its phenomenal success.

With respect to the second proposition,—*viz.*, the intellectual and social elevation of wage-earners through the influence of machinery,—equally numerous and forcible illustrations might be given, but one example will perhaps suffice to emphasize this claim, not only in regard to labor in general, but to self-supporting women in particular.

The modern invention of the typewriter proved a valuable boon to women, opening up immediately new fields of labor of elevating character; but it is doing more than this. The daily experience in affairs which the operators are gaining through their work is fitting them to fill much more important positions in life, and future writers on social economics will be compelled to recognize this new element; but the subject at this point leads off at a tangent from our main topic.

A careful personal investigation into the home life of the well-to-do wage-earning class in Philadelphia (an ideal city in this respect) has revealed remarkable progress in the education and intellectual development of the members composing such families; the "general average" has been raised many points in the life of a single generation; there are comparatively few workingmen's homes in Philadelphia, which I have visited, where you fail to find educational books relating to the occupations of the bread-winners; and the American Encyclopædia is not an *edition de luxe*, kept for show, but a tool of frequent use. The cheapening of such literature through the aid of improved printing-presses is largely responsible for its wide distribution in such homes.

The student who desires to arrive at an approximately correct judgment of the extent of this intellectual and social progress of the wage-earner, which I have endeavored to describe from my own observation, should select a period of time for comparison sufficiently remote from the present to afford striking contrasts; to do this he need not retrace his steps beyond the beginning of the present century.

Great Britain was, at that time, the home of manufacturing industries; cities like Birmingham and Manchester were already congested centers of mill-operative population; the era of mechanical invention had just opened, and its beneficial effects were not yet apparent.

Operatives in factories were herded together like animals, and housed in a worse manner. They were regarded by employers, not as intelligent human beings, having individual mental qualities and endowments, but as so many mechanical units, each one a duplicate of the other. Philanthropists and sociological writers regarded the operatives collectively only, and in the speeches of the great orators in parliament the same impersonal classification is apparent. Even in historical and lighter literature the mental endowment of the mill operative is shown to have been of the most limited kind. Such study will throw into bold relief the contrast between the past and present condition of the wage-earner, which I have only outlined.

With respect to the third and final proposition,—*viz.*, the influence that machinery is destined to exert upon the future relations of capital and labor,—a few thoughts only must suffice to show the nature of my belief.

The labor conflicts which have occurred in the past in Great Britain were, if the evidence is reliable, spontaneous uprisings of masses of downtrodden operatives, driven to despair through long continued oppression. Many battles of nations which are recorded in history were less sanguinary and less prolonged than some of the dreadful industrial disturbances to which I refer.

The strikes which have occurred in recent years in this country have not been spontaneous uprisings, but have been caused and directed by a few ambitious leaders, who have assumed the dangerous position of dictators; they have blindly led hosts of trusting and often innocent followers, usually to ignominious and deserved defeat. These conflicts have been waged, as a rule, against railway and other corporations, and not against individual employers, and have been mainly supported by an ignorant foreign pauper labor element; they represent a phase of development which could, in all probability, have been avoided, had a really great and wise leader opportunely appeared upon the scene.

We have observed the rise and fall of several misguided leaders, and of impracticable labor unions.

The "walking delegate" has disappeared, and the honest workingman has now learned from sad experience to beware of these drones, who thrive without toil by preying upon their fellows.

Never before has labor received the grand opportunity which is now presented to it, in the returning tide of prosperity in this country, to show the refining influence of "trial by fire" through which it has passed, and I am sufficiently optimistic to believe that the coming years will show that the great gulf which separates capital and labor is gradually contracting in area; that, as education permeates the wage-earning class, the employee will perceive more and more clearly that

a community of interest exists between capital and labor which he had not before realized, and will discover that many of the barriers of which he now complains were in reality erected by himself, and will then no longer be required or maintained.

Machinery, which was formerly regarded as the robber of the wage-earner, is destined, in my judgment, to become—indeed, has already become—the missionary for his enlightenment; and, when its work is fully accomplished, the conflicts which have marked this transition stage, often with a trail of blood, will become a memory of a past era of industrial semi-barbarism. I do not mean to imply that I believe the millennium is at hand, or that labor strikes will cease in a day, or in a generation; but I do believe that, just as every new invention in scientific mechanism of warfare is a step toward the ultimate abolishment of barbarous methods of deciding international complications by war, so the general diffusion of education among wage-earners through the aid of machinery and its products is a step toward the settlement by peaceful and intelligent processes of the complex questions which will arise in the future regarding the mutual relations of capital and labor.

NATURAL SCIENCE TRAINING FOR ENGINEERS.

By Prof. N. S. Shaler.

IN the reorganization of the Lawrence Scientific School of Harvard College it has been necessary to consider, once again, the important question as to the share of natural science which should be incorporated in the several four-year courses leading to the bachelor's degree in the departments of civil, electrical, mechanical, and mining engineering. In determining this matter attention has been paid to the previous experience of the school, and, so far as possible, the advice of instructors and of practical engineers has been given due weight. In effecting this reconstruction in the system of the school, the conditions were such as permitted an almost absolute freedom in the choice of subjects in natural science which should be taught. As the Lawrence school is a constituent part of the college, being under the same faculty of arts and sciences, all the extensive establishments for instruction in physics, chemistry, geology, geography, meteorology, etc., could be called on to furnish such teaching as appeared to be necessary in the project for the instruction of engineers. The results of the inquiry have to a great extent been embodied in the schemes of instruction; but it seems worth while to note the points which appear to have been established in the consideration of the problems which have been dealt with.

In the first place, it is evident that all engineers, be their particular division of the profession what it may, are necessarily too much concerned with the properties of matter. It therefore seems necessary to regard a sound general instruction in physics as an essential part of every training which is to fit men for this walk of life. The teaching should be so arranged as to afford much practice in the various kinds of measurements, and this not only because of the practical utility of such work, but also because the educative value of such exercises is exactly what is required to affirm those qualities which need to be developed in the novice. Experience indicates that, when a student in the fitting schools has had a schooling in elementary experimental physics, one course on the basis of nine hours' work each week for the college year is ordinarily sufficient to give the required training. Along with this course in physics should go a similar course in chemistry: the work here should be directed towards the end of giving the pupil a good general knowledge of the principles of chemistry, in the exper-

imental way, so that he may become familiar with the processes of the more important arts. It is not desirable to carry this work very far into the field of quantitative analysis, that being work which is fitted for the needs of the professional chemist. On the side of metallurgy there should be a good theoretical training, with enough in the way of experiment to show the needs of the processes of casting as well as the qualities of the construction metals and their alloys.

In addition to the training in chemistry and physics it is well that engineers in general should know something of geology. The training in this science may well be limited to the general principles of the subject with a considerable exercise in the laboratory work bearing on the characters of rocks microscopically considered,—a task which involves a certain amount of teaching of determinative mineralogy. This work has to be done without recourse to the principles of mineralogical science; it has to be mainly empirical; but, despite the imperfections of the method, much useful knowledge may be attained. In the same elementary course in geology there is a considerable opportunity to learn the processes of field observation and to practise the methods of exploring a district. The time required in this work is about the same as that demanded in the elementary physics,—say nine hours a week during term time. To this geology should be added an elementary half course in geography, which has for its purpose to acquaint the student with the methods of interpreting the history of any area and its more essential relations to the uses of man.

The total time required for the proper study of the elements of natural science as above noted is about four-fifths of the study period of the college year,—the complement of courses for such a year being reckoned at five, while the total of this list is four. It is evident that this demand is, considering the large amount of professional work which the student of engineering has to do, rather excessive. In practice the burden can be much diminished by taking certain of these courses in the summer. For more than a quarter of a century Harvard University has maintained a summer school, in which a number of the elementary and some of the advanced courses which are given in term time are repeated. As each student is required to give his time to one course, it has been found out that the six weeks' term, owing to the concentration of attention, serves to carry the pupil quite as far as he is likely to advance in an ordinary year of work, when the equation for the loss in turning from one matter to another is so great. Therefore the elementary courses in physics, geology, and geography, as well as other courses with which we are not concerned, can, by devoting a share of the preposterously long vacation to the work, be removed from the requirements of the winter session. In practice the

students of the school are rapidly availing themselves of this opportunity to lighten their labors. It may indeed be said that the tendency is to push into the summer term all the work which requires field exercises, and also a certain portion of the instruction which calls for laboratory practice. Including the year of his entrance, a student has four summers at his disposal before attaining his bachelor's degree. By giving up six weeks of each of their vacations he may win all the time required for the elementary science courses which are to be expected of the engineer. There will remain in each summer another period of a month and a half, which is quite as much as is needed, or in this busy world should be expected, by ordinarily well people, for the purposes of rest and diversion. Thus, without sacrifice of any real good,—indeed, we may say with a positive gain to the order of the student's life,—a considerable general foundation in physical science can thus be attained.

When the engineer desires to fit himself for any one of the several branches of his profession by adding to the general training, which should be alike for all those who propose to enter the calling, it is necessary for him to carry his work in particular sciences to a higher plane. These special fields, as they at present appear, may be enumerated as follows,—mechanical, electrical, marine, hydraulic, topographical, and mining engineering. I shall now proceed to consider the science work that is demanded in each of these specializations which lead the student somewhat away from the general path of the occupation.

In mechanical engineering the instruction in physics needs to be carried much beyond the elements ; the student needs to become acquainted with the facts and theory of kinetic action ; he must, in a word, be made ready for the study of the steam engine, and he must also become acquainted with the generalities of hydraulics and the modes of action of fluids and gases.

In electrical engineering the need of an extended training in physics is even greater than in the mechanical division of the subject. The student needs to be well trained in the extensive and increasing difficult lore which is developing in this branch of science. To make him ready, not only to apply the knowledge which has been won, but also to explore for himself in the inventive way in this field where so much awaits discovery, it is desirable to carry him through a range of study which will put him in possession of the electrical science of to-day. In marine engineering, for the reason that the work includes a great variety of considerations which can be fitly approached only in the scientific way, the training has to be very wide; it should include not only advanced physics, but a thorough-going knowledge of hydraulics, and

also a fair teaching in electrical science and its practical applications. If this specialty is held to include the work of harbor and dock construction, which might perhaps be better classed under the head of hydraulic engineering, then there should be added to the curriculum a sound training in that part of geology which relates to the origin and regimen of harbors,—the action of marine currents and waves and the conditions of a geological nature which affect the construction work that the engineer has to do about ports. In part this learning belongs, in a strict classification, to hydraulics ; but, all things considered, it may best be taught by a geologist, for the reason that the science of the earth is a kind of learning which uses the data gathered by investigators in other fields of inquiry to explain the actions which affect the sphere, taking into account the interactions of various causes and their development in time.

In hydraulic work the engineer should be prepared to consider geological problems in a more detailed way than is necessary in any of the special divisions of this science and art. In all that relates to the complicated and most important problems of irrigation the questions as to the origin and nature of the soil, the character of the materials as affecting the storage and conveying of water, etc., need to be considered from the geological standpoint. To this knowledge of geology, strictly so called, should be added a considerable training in physical geography and meteorology. It is hardly necessary to say that the instruction needs include all the abstract science which the university may afford that bears directly on hydraulic problems.

In the special work relating to topographical surveying we find a division of engineering the importance of which has been much underestimated. It is, in my opinion, likely, in the time to come, to be one of the noblest applications of science to the need and the advancement of man. Moreover, though as yet an underpaid branch of the profession, the prizes may be expected to augment as the method of approaching a number of important problems, such as those of the landscape architect, becomes more common. When people are accustomed to use high-grade maps as true pictures of the earth's surface, as they are now beginning to do, we may expect that educated topographers will rank with the other members of the profession of engineering. Those who intend to make this subject their specialty will need a careful grounding in the general principles and the practice of geological field-work. They should also be well trained in the part of physical geography which relates to the interpretation of the development of a surface under the action of atmospheric agents. A map made by a man who knows the under-structure and geographical history of the area which is depicted is a production very different from and more

valuable than a like essay by a topographer who ignorantly endeavors to delineate what he happens to see.

In the department of mining engineering we find the most perplexing part of the task of a technical school. Besides the general training in engineering, which has to be wide, the student needs a very good knowledge of geology, which should be carried far in matters pertaining to the structure, succession, and attitudes of rocks. To attain this end he needs to be fairly instructed in mineralogy and petrography, and to have some acquaintance with fossils as indices of formations. A knowledge of chemistry is equally demanded, and it has to be given in such a manner as will make the man ready for the difficult questions which the miner is apt to encounter. So, too, in the field of physics there is much which should be at the command of the engineer in this department. It may, indeed, be reckoned that, besides the general engineering training, the student who expects to devote his attention to mining work needs a body of natural science which will call for at least 1½ years of the period which he is to devote to work in the technical school. This demand is so large as to make it a question whether a good deal of the work of a practical nature, such as the details of mining methods, ore-dressing, etc., should not be left out of the instruction, with the confident belief that a knowledge of such matters will be readily acquired in the apprenticeship which awaits the young graduate in mining as it does all the men who gain their knowledge in technical schools.

It is, indeed, an open question whether our science schools are not going too far in the effort to acquaint their students with the technical details of the several departments of engineering. This instruction is given with the expectation that the graduate may the sooner be able to command a responsible and remunerative place. But it is very doubtful whether the imitations of economic establishments which are devised are not, by their lack of business quality, calculated to develop erroneous methods which will go far to offset any knowledge of the crafts which they may teach. It is likely that in the end our schools will confess a limitation in their work, and win firm ground by acknowledging that their province is to give the student a thorough education, in the original sense of the word, supplying him with a large theoretical outfit, leaving the technique of his occupation to the time when he begins his work in a particular employment. If this position is taken, there is room in a four-year course, including six weeks of each of the four long vacations, for much of the work in natural science which has been noted in this paper as proper to be introduced into the curriculum of the several departments of engineering. It seems to me that this system is very desirable for the reason

that the more extended basis of scientific knowledge on which the profession would then be founded would at once dignify the education and enlarge the men who receive it.

There is another consideration which leads us to believe that the share of natural science which is introduced into the training of engineers should be large; this rests upon the need of making the men of this profession the compeers in intellectual station of educated men of the other learned occupations. In order to prepare young men for a career in engineering without an excessive expenditure of time, it is necessary to educate them in a different way from that which experience has approved for the ancient standard callings. We have to abandon the classics and much else which makes for enlargement, and trust to science to win the ends of culture. While I fully believe that natural science can do an excellent part in the civilizing process, it cannot do this if the teaching be devoted to immediate ends. The work must be done in the large, truly academic way; it must take the subject for itself, and not as a mere means to a professional result.

The foregoing remarks concerning the amount of natural science to be taught in our schools rest upon the practice of giving the bachelor's degree in engineering at the end of four years. I cannot close the consideration of the subject without a brief reference to the present attitude of our schools as regards the period of study demanded of candidates in engineering. On the basis of a preliminary training which requires at least one year less than in the case of those who enter our leading colleges, we endeavor in four years to complete an education which shall fit a man to take up his life's work in one of the most difficult callings, one in which the demands that are made on the practitioner's education are continually and rapidly augmenting. We expect the lawyer or the physician to give one or two years' additional work in the preparatory school and four years in the college before he enters on his professional education; we permit the engineer to win his lower goal with from five to six years' less study. While the way to a profession through the path of the college may be held to be too long, that through the technical school is clearly too short for the needs of the work their graduates have to do. At least one year should now be added to the length of the curriculum.

With the addition of a year to the length of the term-work of our technical schools, it would be much easier to secure a fit share of natural science in the curriculum of the engineers. There would also be a decided gain in the opportunities for instruction in English, French, and German. Moreover, the distribution of the professional studies could be much better accomplished than is possible in a four-year system.

LABOR LEGISLATION IN THE UNITED STATES.

By George Kirby Holmes.

LEGISLATION relating to labor is every year becoming more and more comprehensive, and at the present time covers a great variety of conduct, more particularly that of employers; and the question is being asked whether that point has not been reached at which this legislation is beginning to be oppressive to capital.

Much of the so-called factory legislation aims to accomplish what Herbert Spencer believes should be accomplished by the workingman himself, and is therefore a foolish paternalism. If elevator-shafts and dangerous machinery are not provided with guards, and mill doors do not swing outward, it is argued that workingmen should procure the protection that they desire by arrangement with their employers, and not procure the State's mandate to take the place of what properly belongs to the domain of private agreement. But this contention of Mr. Spencer and his extreme followers is applicable to an ideal society, or at any rate to one much more nearly ideal than our own. It is opposed by the argument that the workingman is often so near starvation, and his opportunities for employment are so limited, that he is not in a position to confer with his employer upon an equal footing.

The latter argument, carried to its logical conclusion, would require the State to take the part of the workingman in his relations with his employer within the entire field of contract, and no one but a radical Socialist would go thus far. It must be admitted that all legislation of this sort, as Mr. Spencer claims, tends to weaken the workingman's spirit of self-help, and, if any of it is to be defended, the defence must take the ground that, under the present imperfect conditions, some degree of compromise is desirable,—one that shall require the employer to do some things which unquestionable fairness dictates that he should do, and leave the workingman to strive for enough to develop his individuality and to promote his coöperation with his fellow-workingmen.

No theory can define the limits of such a compromise, but that there should be some sort of compromise is a conviction which has for years been growing in public opinion, and growing so rapidly lately that there may be danger of carrying it too far in the assumed interest of the workingman.

Labor legislation in which society may be regarded as having an

interest, although not always the only interest, now includes a limitation of the hours of labor, much more of women and children than of men; the prohibition of certain employments to women and children; and the prohibition of the employment of children under specified ages and without a certain period of instruction in schools. It includes the securing or preference of wages due from employers of various descriptions; it authorizes instruction in the use of hand-tools in the public schools; it forbids the importation of alien contract labor, the employment by railroad companies of persons who are color-blind, and the employment of children under specified ages in cleaning machinery in motion or near other machinery that is dangerous.

There are laws to facilitate the formation of relief societies by workingmen, to exempt from seizure under execution the tools and materials necessary for carrying on a trade or business, and to exempt from garnishment the wages of the wife and minor children of the defendant and his own wages up to a specified amount. Convict and Chinese labor are more or less limited or altogether prohibited, the manufacture of cigars in tenement-houses is forbidden, and free lectures for working people are provided for.

Such, briefly stated, is the specific character of the legislation relating to labor in which society may be regarded as having an interest outside of any considerations of abstract justice. Within the domain of justice the legislation has been varied, and has considerably reinforced the common-law rights and responsibilities of employer and employed, besides enlarging them in some important respects.

It is provided that no person may by force or threats of violence prevent another person from doing any lawful work or from carrying on any lawful industry, business, or calling. Liens attach to property upon which labor has been bestowed or for which materials have been furnished, to secure wages and prices; no person, on account of sex, is disqualified from entering upon or pursuing any lawful business, vocation, or profession; the obligations of employees to perform service that has been contracted for is enjoined, and in some States this is done with special reference to employees on railroad trains and steamboats to prevent their abandoning the same before a trip that has been begun has been completed.

The common law of master and servant is more or less redefined and made more certain. The earnings of married women are secured to them as against their husbands. Blacklisting is made a crime. Employment offices can not be kept open except under certain regulations, and deception by their proprietors is forbidden.

To prevent accidents from the ignorance of stationary engineers, such engineers must have successfully passed an examination; persons

under certain ages are not allowed to have charge of elevators; and railroad companies can not employ telegraph operators without a thorough examination to establish their competency. It is a crime for any organization to prevent any person from apprenticing himself to learn and practise any trade or vocation. Railroad companies can not exact from their employees any portion of their wages to maintain a hospital, reading-room, library, gymnasium, or restaurant. The common law does not recognize damages for the instantaneous death of a person, and this has been changed so that the legal representative of a railroad employee who has been killed in the performance of his duties may carry on a suit for damages; and the common-law liability of employers for injuries to employees has been considerably enlarged.

Laws make it a crime to threaten to discharge from his employment, or to reduce the wages of, any voter, or to promise to give him employment or higher wages, for the purpose of influencing his vote. No offensive, derisive, or annoying words may be addressed to any person passing along any street to, from, or about his lawful occupation, nor can any noise or exclamation be made in his presence or hearing while so passing for the purpose of preventing him from pursuing it.

A person is guilty of a crime who breaks a contract of service, having reasonable cause to believe that the probable consequence of his so doing will be danger to life, or bodily injury, or loss or injury to valuable property. Boycotting is forbidden in Illinois, Maine, and New York, but is permitted in Maryland.

An examination of the legislation coming within the definition of justice shows that it is even more against the practices of workingmen than of employers, and that, as in the case of legislation (already considered) outside of justice and pertaining to the general social welfare, most of it has the approval of public opinion and will probably remain permanent in the body of our laws.

There now remains for examination the labor legislation that relates to matters outside of justice and general social welfare, in regard to which it may be questionable whether they should be left to regulation by contract. There is hardly any limit that this class of legislation may reach, and, while some of it prescribes duties for workingmen, by far the larger portion of it places responsibilities upon employers and may be extended a little at a time, so as eventually to become burdensome to them.

Massachusetts has gone farther in this legislation than any other State, as it has in the two other classes of legislation; indeed, the labor legislation of that State exceeds in variety, perhaps, that of all other States combined, especially so if mining laws are excepted.

An employer there cannot, by contract, exempt himself from liability for injuries to an employee which he might otherwise be under; he cannot exact from an employee, under forfeiture of wages, a notice of intention to leave his employment, without himself being subject to the same penalty for want of similar notice of discharge; and he must provide seats for female employees in manufacturing, mercantile, and mechanical establishments, and permit such employees to use them when their duties permit.

Factories and workshops must be suitably ventilated and provided with sanitary arrangements; there must be fire escapes and methods and means of protection from accident; elevators must be provided with automatic safety clutches, and elevator shafts with self-closing hatches at every floor. No explosive or inflammable compound can be used in any factory in such a place or manner as to obstruct or render hazardous the egress of operatives in case of fire; outside and inside doors must not be locked; if steam power is used, communication between each room where machinery is placed and the engine-room must be possible by means of speaking-tubes, electric bells, or appliances that may control the motive power; women and young persons must be allowed to eat their meals at the same time, and must not be employed for more than 6 hours without an interval of at least half an hour for a meal.

There must be no fines for imperfect weaving, unless it is due to the wilfulness, negligence, or incapacity of the weaver, and they must not exceed the damage agreed upon by contract. No building intended to be used as a factory or workshop, or for mercantile purposes, above the second story and with accommodations for ten or more employees above that story, can be built, unless its plan is sanctioned by a specified public officer, who must see that various provisions are made for escape in case of fire and for the prevention of fire.

The construction of factories, workshops, stores, and boarding and tenement houses is subject to numerous and minute regulations pertaining to fire and health, under the supervision of a public officer, whose judgment and decisions are almost autocratic. Certain freight-cars must have safety couplers, and bridge guards must be erected to protect trainmen. Wages must be paid weekly by nearly all corporations. Besides requiring all these things, the State promotes agreements between capital and labor through voluntary arbitration, and it strengthens the contracting ability of labor by incorporating labor organizations.

Massachusetts has led in this sort of legislation, and other States have adopted many of its labor laws. In addition to this, some of them forbid employers to maintain stores, or to sell merchandise to

employees for a higher price than to other persons for cash, or to coerce employees to buy at any particular store or to employ any particular physician. The cause of discharge is to be given in writing to an employee upon demand.

In some States the wages of labor employed on public works is fixed by law, but under the constitution of Louisiana no law can be passed to establish the price of manual labor. In Michigan workmen must be protected from emery dust by suitable blowers and apparatus. Wages must not be paid in Missouri with any evidence of indebtedness payable otherwise than in the money of the United States or in merchandise at current cash prices. Seats must be provided for New Jersey horse-car drivers, and in that State wages cannot be paid in merchandise or in orders or due bills. Every contract that will keep, or is designed to keep, voters away from the polls in Tennessee is void.

The most elaborate coal-mine regulations are those of Pennsylvania, and they are so elaborate that there is not space for even the most condensed abstract of them. It must be sufficient to say that they include numerous requirements with respect to shafts, slopes, structures over the surface entrances, hoisting apparatus, blasts, machinery, facilities to enable miners to change their clothes and to wash and to care for the injured. ventilation, the prevention of accidents, the organization of the working force, and the manner and means of work in great detail.

In the foregoing review of labor legislation it has been impossible to mention, even briefly, numerous qualifications of the principal features of the laws, nor has it been thought necessary, in all cases, to mention the States in which the various laws prevail.

A law, intended to accomplish a single purpose, rarely confines itself to that purpose, and doubtless the labor laws have had and will have unexpected results, immediate and remote. Much of the legislation is too recent to have produced results that can be ascertained without extended investigation, and, if they were ascertained, it would be found that they are generally not measurable.

In Massachusetts the child labor laws have had the effect of almost entirely suppressing the factory labor of children within the prescribed ages. A law was enacted in 1876 prohibiting such labor under the age of 10 years in factories and workshops, and statistics show how far it has accomplished its purpose. The percentage of children employed in manufacturing in 4 census years is exhibited below, the percentage being computed upon the total number of persons of each sex and of the total of the two sexes, of the specified age periods, in the population.

	For both sexes.	For males.	For females.
1870, males below 16 and females below 15	3.17		
1875, below 15	2.45	2.78	2.13
1880, males below 16 and females below 15	3.31		
1885, below 14	0.70	0.82	0.58

In 1870, before the enactment of the child labor laws, 14,119 children (males under 16 years and females under 15 years) were employed in manufacturing in Massachusetts; in 1880 the number rose to 17,445, but fell to 8,877 in 1890, owing to the law of 1888 raising the prohibited ages from those below 10 years to those below 13 years. These children are mostly 14 and 15 years old, since, according to the State census of 1885, the children under 14, employed in manufacturing, were 3,508, and this number must have been reduced almost to nothing by the law of 1888. In 1885 there were only 24 children under 10 years of age employed in manufacturing.

Whatever the effects of labor legislation have been in Massachusetts, they have not been felt in a way to prevent the employment of a constant portion of the adult population in manufacturing.

The following percentages show the portions that the males and females employed in manufacturing are of the total male and female population, for the special age periods:

	For males.	For females.
1870, above 16 (population above 15)	37.25	
" " 15 " "		16.20
1875, " 15 " "	37.67	14.55
1880, " 16 " "	39.72	
" " 15 " "		16.05
1885, " 14 " "	38.42	15.01

Although the foregoing percentages have not a uniform basis, they are sufficient to indicate no material effect upon the employment of working people, numerically and relatively, in factories.

If labor legislation had, in fact, produced any injurious effect upon capital, no one of them would make itself manifest more quickly than the one that touched capital's pocket. The 10-hour law was passed in Massachusetts in 1874, and at that time the hours of labor in factories were 11 in the other New England States and in New York, and often 12 in Connecticut. Here was an apparent increase of about 10 per cent. in the cost of production in Massachusetts, whose competitors were nearly all in neighboring States.

To ascertain the effect of this law the legislature directed the Bureau of Statistics of Labor to investigate, with results that can hardly fail to lead to the opinion that labor legislation would need to be very drastic before it would be felt by capital to its manifest disadvantage. After this reduction in the hours of labor had continued for

7 years, mill-owners in the adjoining States were asked how they had been affected by it, and, out of 120 who made definite answers, 100 said that there had been no effect, 10 reported that the effect had been favorable to them, and 10 reported that the effect had actually been unfavorable.

Of 102 mill-owners in adjoining States, 13 said that the 10-hour law in Massachusetts had enabled them to undersell their competitors in the latter State, and 89 denied that it had done so in their cases. In the report of the investigation, the chief of the bureau, then the Hon. Carroll D. Wright, says: "It is apparent that Massachusetts, with 10 hours, produces as much per man, or per loom or per spindle, equal grades being considered, as other States with 11 or more hours; and also that wages here rule as high, if not higher than in the States where the mills run longer time."

For want of published material, no definite conclusion of fact can be made in regard to the effects of most of the labor legislation. We know, however, that capital is sensitive to whatever makes it suffer loss, or puts it in danger of loss, and to whatever hampers its operations, and that, with a large control of the daily press, it can make its cries heard, and will do so for any length of time necessary to bring relief. Capital has another way of protesting, which legislation never contemplates and that came prominently to notice in consequence of the so-called "granger legislation" relating to railroads in some of the western States. So severe was it that railroad development ceased, and the people so suffered for want of railroad facilities that they abandoned their anti-railroad policy.

The probability is that, if any labor legislation were oppressive to employers, their conduct would naturally be such as to give their employees a share of the ill effects. For instance, if the law in relation to fines for imperfect weaving is unsatisfactory to factory owners, they have only to dispense with the services of the weavers who, under the law, are not desired. Then workingmen themselves would ask for a repeal of the law. In this way employers have a very effective remedy for excesses committed against them by legislatures.

Labor legislation has become so elaborate that it may be pertinent to question whether, in such a State as Massachusetts, where it has been carried farthest, it may not be better to leave labor to look more after its own interests and the legislature less. If employers complain of too much labor legislation, they may be reminded that, if they were more approachable to their employees and were imbued more with a spirit of compromise, legislatures would be doing less, and workingmen might not have formed the habit of asking the State to do what they should strive to do themselves.

THE MODERN PROBLEM OF GRADE CROSSINGS.

By William O. Webber.

THIS problem has become one of great importance during the past 20 years, and, since the introduction of the electric street railway 8 or 10 years ago, the intersection of highways on which it is in use with steam railroads has complicated the problem and made its solution imperative. The present state of things seems to have been brought about by the indifference of the people to this question in their eagerness for railroad facilities, and by the poverty of the railroads when new. There was also an element, still surviving to a certain extent, which objected to any change in the grade of the highways, preferring to take its chances at the same level. There is also a surprising lack of information, or rather an abundance of misinformation, regarding the status of this problem. As a rule, about 28 per cent. of these crossings in the New England and Middle States are supposed to be protected. Gates and flagmen do not protect. If the gates effectually closed up the road and kept people away from the track until it was safe to cross, they would be much better; but at present only a very few pedestrians pay any attention to them. About 40 per cent. of all the crossing accidents have occurred at these "protected" crossings. There is about one grade crossing to every mile of railroad in the territory mentioned above. Grade crossings are the rule on three-fourths of the roads.

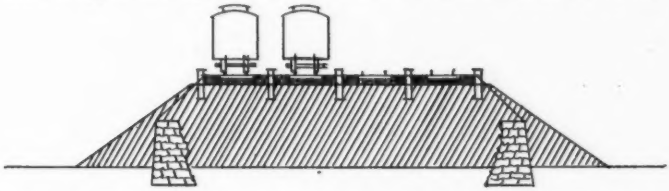
There are five types of these crossings.

First: where the highway is raised and carried over the original location of the railroad. This is the most common type, and is well illustrated by Fig. 4, which shows a highway bridge over the four tracks of the New York, New Haven & Hartford Railway at Larchmont, N. Y. This bridge is of plate iron, the floor being carried on I beams, suspended beneath the side trusses and between the tracks, so that the truss will not come over the centre of the passing train. There is a clear head-room of 18 ft. above the rails, with a raise of only 19½ ft. of the road-way above the track,—only 1½ ft. being required by this system of flooring. The cost of such a crossing over a four-track railway and with a 40-foot roadway is about $18,000.

Second: Where the highway is carried under the original location of the railway, which is probably the method that stands next in point of frequency. This is well illustrated by Fig. 5, representing a

crossing near Port Chester, N. Y., on the New York, New Haven & Hartford Railroad. The bridge over the roadway is carried by half-through plate trusses on masonry piers set between the sidewalk and the roadway on the curb line. The railway tracks are then carried over the sidewalk by short I beams, which are connected with and riveted to these trusses. This is probably the cheapest form of construction for such a separation of grades, and from this point of view is to be generally recommended; as to its durability and beauty, we shall have something to say further on.

Third: Where the highway is carried under, and the railroad is also raised, as shown in Fig. 6, which represents a crossing at Holyoke, Mass., on the Connecticut River Railway, now operated by the Boston & Maine system. In this example the roadway is sunk below the sidewalk, which is left at about its original grade, and a plate truss is carried over the whole opening, but supported by iron lattice posts on the curb line and also in the centre of the roadway. The roadway has been dropped about 5 ft. and the railroad has been raised about 10 ft.,



4-TRACK RAILROAD ELEVATED ON EARTH FILL WITH SIDE SLOPE AND PART RETAINING WALLS—ALSO SHOWING POSITION OF PLATE TRUSSES TO CARRY RAILROAD OVER HIGHWAY.

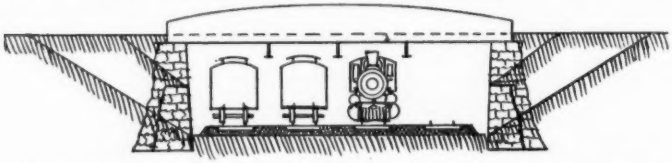
making the head-room over the roadway about 13 ft. and leaving the head-room over the sidewalk about 8 ft. Other illustrations of this type of crossing will be shown further on.

Fourth: Where the railroad is carried over the highway, the latter being left on its original grade. A very good illustration of a similar separation of grades of this class is shown in Fig. 7, representing a crossing on the Dedham branch of the New York, New Haven & Hartford Railroad, Providence division, at the site of the old Bussey "Tin Bridge." This is a sightly structure of Ashlar masonry, but is perhaps a little too severe in its appearance except for use in the rural districts among hills and heavy timber. Other examples of this class of crossing on a grander and more continuous scale is shown by the masonry viaduct of the Pennsylvania Railroad from West Philadelphia to the Broad street station, through Philadelphia.

Fifth: Where the railroad is carried under the highway, the latter

being left at its original grade. This method is very rarely employed; Figs. 2 and 3 illustrate it.

Railroad structures over highways seem to be the coming practice, especially in populous districts. People congregate about the streams and water-courses in valleys, where a separation of grades by raising the railroad is always attended by a benefit in the general gradient of the railroad, and gives greater head-room to all traffic on the river or streams passing beneath the railroad bridges. Furthermore, by reason of the close proximity of a great number of highways to the railroad, it is less expensive to raise the railroad than to raise the streets and pay damages to adjacent property. This question of damages and costs will be referred to later. More ornate examples of railroad structures over highways are to be seen at Springfield, Mass., on the main line of the Boston & Albany Railroad, where the railroad has been carried over the main street on a beautiful arch of masonry, as shown in Fig. 8; and similar bridges are being built at Brockton, Mass.,—the cost of the 50-ft. arches for four tracks being estimated at $23,500,



4-TRACK RAILROAD DEPRESSED IN EARTH CUT, WITH SIDE SLOPE AND PART RETAINING WALLS—ALSO SHOWING PIERS AND PLATE TRUSS BRIDGE TO CARRY HIGHWAY OVER RAILROAD.

and for the 41.25 ft. spans for four tracks about $17,500,—on the Old Colony division of the New York, New Haven & Hartford Railroad.

Stone or masonry is always to be recommended for this purpose. from the standpoint of economy, although the first cost is much larger The Pennsylvania Railroad Company evidently understood this when it built its viaduct into the Broad street station in Philadelphia, having found that the average life of iron bridges on its road was only about 14 years, it being very difficult to prevent them from rusting or the rivets from working loose in the plates. Iron or steel structures are also calculated only for a given maximum load, and, as the rolling-stock of all of our railroads is continually increasing in weight, the iron structures need often to be strengthened or entirely replaced; while a masonry arch, once in place, lasts forever, is stronger than any other known form, and practically increases in strength, up to the crushing-point of the stone, with the load placed upon it; from an artistic point of view, too, it is much preferable, as may be seen in Fig. 8.

FIG. 1.—BEGINNING OF CUT, FORDHAM, N. Y.

FIG. 2.—CUT NEAR MELROSE STATION, N. Y.

FIG. 3.—SOUTH FROM MELROSE BRIDGE.

Other things being equal, it is always less expensive and more expedient, both as regards time and obstruction to traffic, to raise the railroad over the highway. In the first place, whether built on an embankment with the natural sloping walls or with retaining walls built up part way, the elevated railroad better accommodates itself to a narrow location, as may be seen by the two accompanying sketches, both of which are for a four-track location with the tracks 15 ft. apart from centre to centre,—which is rather more than common, 12 ft. being the average. The elevated railroad has 15 ft. of head-room over the highway, the trusses carrying the railroad being 6 ft. in depth, and the depressed railroad has 18 ft. of head-room under the highway bridge, the top of the floor of which is 19½ ft. above the rails on the railroad track, both cases conforming to the law in the States where they occur. In the elevated structure, with the walls built up part way, the location occupies 80 ft. In the depressed road, with similar walls, the location would occupy 95 ft. With retaining walls built up the whole height the elevated structure would require only from 60 to 65 ft., while the depressed railroad would require 90 ft.; on earth embankment with natural slopes the elevated road would require 115 ft., and the depressed railroad in an open cut with natural slopes would require 135 ft.

It is also easier to raise a railroad track by dumping grading on either side of the track and lifting the track a foot or so at a time, tamping the material under and allowing trains to be run slowly over the track so raised, until it is thoroughly tamped and settled. In depressing tracks it is necessary to build a parallel track alongside the present location and tear up original track so as to dig under it. Of course, if a four-track railroad was to be raised and the location was one where there were many highway crossings in close proximity, it would probably be better to start by building trestles over the highways and a new grade on two of the tracks, utilizing the other two for traffic, and afterwards to shift the traffic to the two tracks thus raised, and then raise the two remaining ones. This was the way that the Illinois Central Railroad raised its track opposite Jackson Park in the southern part of Chicago. Notable examples of railroad elevation (perhaps with slight depression of the streets) shortly to be undertaken in thickly-settled communities are to be seen on the Providence division of the New York, New Haven & Hartford Railroad, from Chickering station in Boston to Forest Hills and Mt. Hope station,—a distance of about 2 9-10 miles. These changes will abolish twelve very bad grade crossings,—that at Tremont street in Boston, long known as the "Roxbury Crossing," being one of them.

The railroad will be raised as much as 16 ft. in some cases, and

FIG. 4.—HIGHWAY BRIDGE OVER RAILROAD, LARCHMONT, N. Y.

FIG. 5.—HIGHWAY, UNDER RAILROAD, PORT CHESTER, N. Y.

FIG. 6. — MOSHER STREET UNDER RAILROAD, HOLYOKE, MASS.

the streets depressed all the way from 1 ft. to 5½ ft. The proposed changes introduce a maximum grade of only 29 ft. per mile, while that of the old location was considerably more. All through trains on the main line going south have to go up a 42-ft. grade near Canton, and all trains going to the Dedham branch have to ascend a 49-ft. grade near Forest Hills. The carrying out of this plan will abolish all the grade crossings on the main line of the Providence division for a distance of 10.87 miles from the Park square station in Boston. The cost of this work, including the widening of the location to accommodate a four-track road (it is now only three-track), as well as the building of the bridges and a number of new suburban stations, is estimated at about $2,500,000.

Another example is to be seen at Brockton, on the Old Colony division of the New York New Haven & Hartford Road, where the track is to be raised for a distance of about 2 miles and carried under for a little over ½ mile. The railroad is to be raised from 8 to 10 ft. at the maximum, and the highway to be carried under, except at the south end, where the street is to be raised the whole distance of 19½ ft. The present gradients of the railroad are 37 and 25.34 ft. per mile, while the proposed changes introduce a maximum grade of only 32.7 ft. per mile. The whole cost of this work, including new station and other improvements not strictly due to the raising of the track, will be about $1.500,000.

One of the first great improvements of this nature in this country was the work done on Fourth avenue, in New York city, by which forty-five grade crossings were abolished, the whole cost, including the Fourth avenue tunnel, the widening of the road-bed from two to four tracks, and other improvements to adjacent property, being $6,100,000.

The New York & Harlem Railroad Company has recently lowered its tracks in the twenty-third and twenty-fourth wards of the city of New York for a distance of about 5 miles, at the same time providing for two additional tracks, constructing twenty two overhead street bridges, mostly for new streets, and making numerous incidental improvements. The total expense to the railroad was about $2,000,000. Fourteen grade crossings will be abolished by the change. This work was done without interruption to the traffic on the railroad by the following method: A new track was laid at the right of the old location, as shown in Fig. 1. The earth was then removed between it and the old track by teams and steam shovels, until the maximum depth of 12 ft. was reached. The wall shown in Fig. 2 was then put in. The overhead bridges shown in the same cut were then erected, but these were blocked up above their piers on tempo-

FIG. 7.—NEW BUSSEY BRIDGE, DEDHAM, MASS.

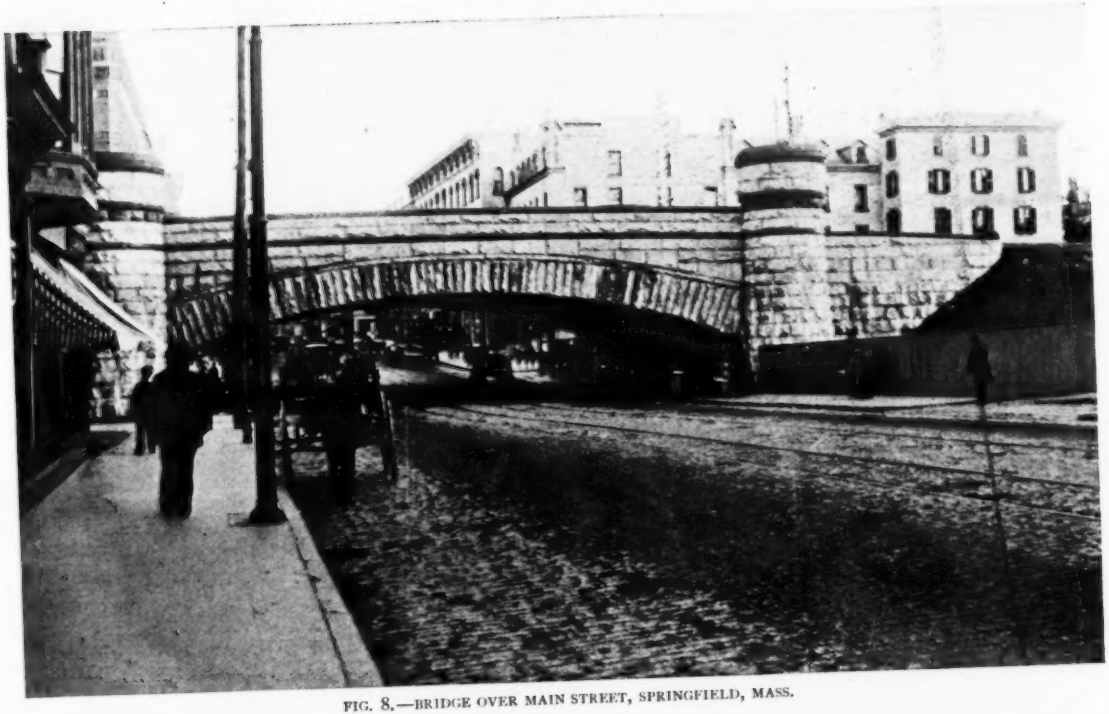


FIG. 8.—BRIDGE OVER MAIN STREET, SPRINGFIELD, MASS.

FIG. 9.—A DIFFICULT PROBLEM NEAR BLACKSTONE, MASS.

A highway crosses one railroad at grade and goes under another. Blackstone river prevents carrying highway under both railroads. Views are obstructed in all directions by covered bridges and railway embankments.

rary blocking sufficiently high to clear the traffic on the original tracks. A new permanent track was then laid at the bottom of this new depressed location, graded and ballasted, and used for traffic. The earth was then removed from beneath another track, which was lowered in the same manner, and in some places two tracks were lowered part of the way at the same time; the highway bridges were then lowered from their blocking into place as shown in Fig. 3, until finally all four tracks had been reconstructed in their new location and the retaining wall built at the left, opposite the location of the original wall. This depression extends from Mott Haven station near the Harlem river, just across from Manhattan island, to a short distance above Bedford Park. By this change the maximum grade of the railroad was decreased from 37.38 to 36.32 ft. per mile.

The New York Central & Hudson River Road, with its four tracks, was raised in Rochester, N. Y., for a distance of about 2 miles, and carried over the streets at a cost of $1,726,617.62, including in this amount $560,074.79 for land and land damage.

The New York, New Haven & Hartford Railroad has abolished nearly all the grade crossings on the main line between New York and New Haven, at a cost of about $10,000 to each crossing. From the figures obtained from these examples and other work of a similar nature, it appears that the cost of changing a four-track trunk line, either by raising or lowering, through a thickly-settled community, is about $500,000 per mile, not including land damages. On lines of less than four tracks this figure is reduced by about $100,000 per mile for each track omitted. The cost of abolishing a grade crossing on a country road, with buildings adjacent, may be estimated roughly at about $10,000 to $12,000, including labor and material on both railroad and highway, as well as land damages, if any. On a village street which is built up with houses, as is usually the case, $18,000 would be an average cost. In a village square, where two or three streets meet and form the square, and the business blocks of the village surround the square, the cost of separation would be about $50,000. In an ordinary city street, built up with ordinary three story brick blocks, $90,000 would be the average; and in a city square where two or three streets meet, and a better class of blocks exist, $150,000 each would be the cost. In a city where water, either in canals or rivers, or other extraordinary conditions, are found in close proximity to the crossing this cost may run as high as $200,000 or even $250,000.

The matter of apportioning the cost of the separation of grades is one of grave importance. While undoubtedly the people, in the first place, do not want the location and surfaces of the highways disturbed, preferring to take the risk of crossing at grade rather than go

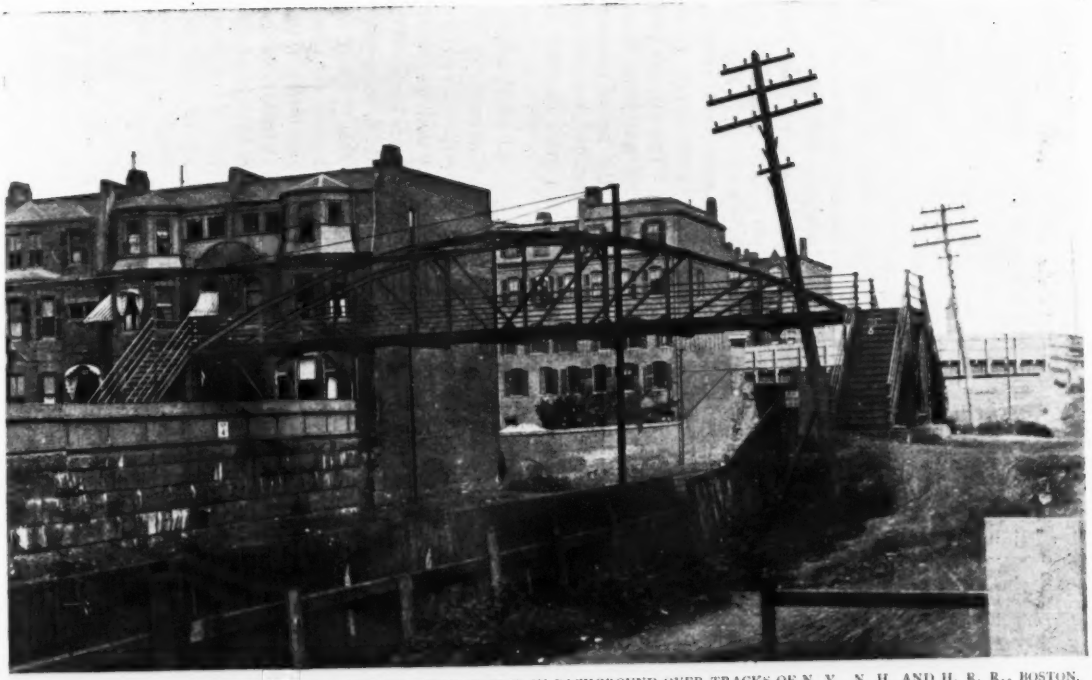


FIG. 10.—FOOT BRIDGE IN FOREGROUND AND HIGHWAY BRIDGE IN BACKGROUND OVER TRACKS OF N. Y., N. H. AND H. R. R., BOSTON.

out of their way to pass under or over the railroad, or to some other location where they could cross more easily either under or over; and while the railroads claim, as a matter of fact, that they can not build their roads except they are allowed to do so at grade, because of the extra cost; and although, because of these two objections, the town, county, and finally the State authorities acquiesce and allow these crossings to be constructed at grade,—still the latter-day view of governmental functions considers that people must not be allowed to injure themselves or each other, and hence, on the broad ground of the greatest good for the greatest number, the authorities are in some degree responsible for the original shiftless construction, and ought to help pay the cost of the change. As a matter of fact, it need not have cost so very much more, except in especial cases, to have built the railroads without any crossings at grade. In proof of this, the Northampton extension of the New York, New Haven & Hartford Railroad, through the town of Deerfield, Mass.,—a distance of about 16 miles,—was built for about $25,000 per mile, without any grade crossings, going over or under fourteen highways. The average cost of construction of a railroad of this class at that time was from $20,000 to $22,000 per mile. As a matter of fact, the actual expense strictly pertaining to the building of these over- and under-crossings, was $67,612.22, or a little over $4000 for each grade crossing so avoided.

The Massachusetts legislature passed, in 1891, a bill which places 65 per cent. of the cost of separating grades on the railroad, 25 per cent. on the State, and 10 per cent. on the city or town, and recently has passed another bill providing that the town or city shall pay more than this 10 per cent. if it requires special methods of construction and extras that will be of sole benefit to the town or add to its appearance in any way. It has always seemed to the writer that the city or town should grade the streets and pay all land and grade damages, while the railroad should do all work within its own location, including the building of bridges, whether to carry the railroad over the highway or the highway over the railroad; and that bridges of the latter class should be kept in repair by the town. The cost of these changes should be apportioned by a commission specially appointed for each case, and very nearly in the proportion of the work to be done by each party; or, preferably, by a permanent commission in each State, which should have authority over such matters, and whose experience, growing from year to year, would become of more use to the State and the people. However this matter of costs is apportioned, the people must sooner or later pay for it, either in the form of additional taxes or higher fares.

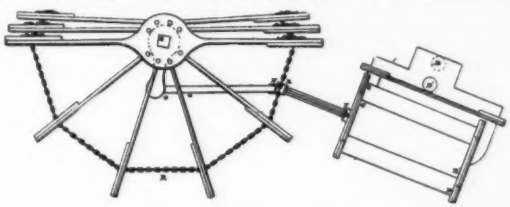
THE EARLIEST TRANSATLANTIC STEAMSHIPS.

I.—1819–1855.

By Samuel Ward Stanton.

ON May 29, 1819, while the little schooner Contract, Captain Livingstone, was sailing quietly along on the Atlantic, in latitude 27° 30′, longitude 70°, the lookout discovered what he supposed to be a vessel on fire, far off on the horizon. The Contract was headed toward the new comer, but, to the surprise of those on board, she passed along quickly and was soon lost to sight, notwithstanding all sail on the Contract was spread. The conclusion was then reached that the strange vessel was nothing more or less than a "steam packet," bound across the ocean.

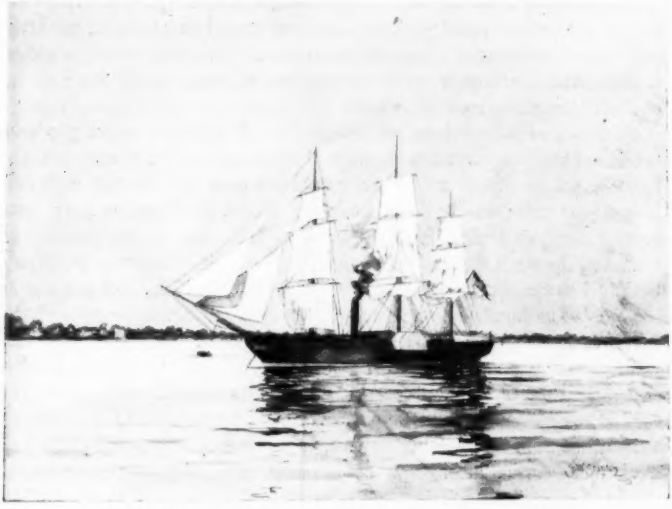
The vessel in question was the Savannah, a ship of some 380 odd tons, and she was bound to Liverpool from Savannah, having left the latter place on May 26. The Savannah was the first transatlantic steamship. She was built at Corlaer's Hook, on the East river, now part of New York city, by Messrs. Crocker & Fickett, and was at first intended for a sailing packet, but before she was finished was purchased by William Scarborough and others, of Savannah, Ga., and machinery was placed in her. The engine—inclined direct-acting—was built by James P. Allaire, and the boilers by Daniel Dodge. The paddle-wheels were so constructed that they could be taken apart with little trouble and placed on deck should occasion arise, the shaft having joints for that purpose. Skeleton frames, of iron designed to surround the wheels, and covered with canvas, served for wheel-houses. The Savannah's arrival at Liverpool created a small sensation; steaming up the harbor, with sails furled, a full head of steam on, and the American flag floating proudly over her, she no doubt presented an inspiring sight. The trip had occupied 22 days, on 14 of which steam was used. Leaving Liverpool, the Savannah sailed to St. Petersburg, stopping once or twice on the way, and finally returned to Savannah. The machinery was afterwards taken out, and she plied



WHEEL OF THE SAVANNAH.

as a sailing packet between New York and Savannah. She was finally wrecked on the Long island coast.

Soon after the Savannah made her successful ocean trip, a fine large steamer, named Robert Fulton, of 750 tons, was constructed in New York by Henry Eckford, for the route from New York to Cuba and New Orleans. She was a stanch vessel, constructed "entirely of oak, locust, and cedar, and Georgia pine, copper fastened." She had a square, or cross-head, engine, of the type then in use on inland steamers; there were two boilers and two funnels. She left New York for New Orleans on her first trip April 25, 1820, stopping *en route* at Charleston and Havana. She was an entire success, and covered the



THE SAVANNAH, PIONEER TRANSATLANTIC STEAMSHIP, 1819.

2225 miles between New York and New Orleans in an average of 10 days. The New York *Evening Post* of June 15, 1820, contained the following notice of her arrival:

The beautiful steamship Robert Fulton, Capt. John Mott, arrived last evening, 17 days from New Orleans, *via* Havana and Charleston. At Havana she stopped 2 and at Charleston 4 days. She has aboard between sixty and seventy passengers, and has been at sea only 10 days.

In another notice, on the return of this boat in January, 1821, the *Post* said:

Steamship Robert Fulton, Capt. Mott, arrived in New York in 8 days from Charleston, having been to New Orleans . . . . 54 days' round trip to New

BRITISH STEAMSHIP SIRIUS, 1838.

The first regular transatlantic passenger steamer; 170 feet in length; 703 tons.

Orleans, averaging 14½ either way . . . . The boisterous season, the rough and heavy weather which she has experienced this trip, must convince even the most incredulous of the perfect practicability of navigating the ocean by steam. Capt. Mott gives her a decided preference over every vessel he ever commanded, both for safety and pleasantness during a gale of wind.

The Robert Fulton ran for three years very successfully; she was then sold to the Brazilian government, to be used as a cruiser, her machinery being removed.

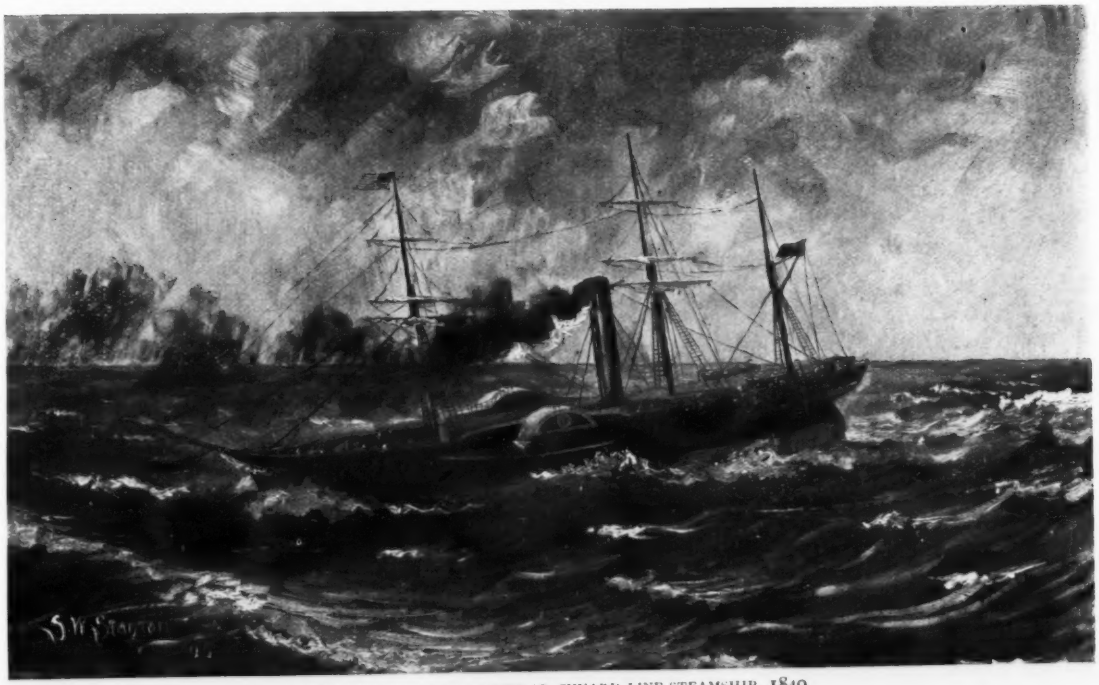
Various small coastwise lines were in operation both in the United States and Great Britain between 1825 and 1835. In 1825 the steamship Enterprise made the trip from England to Calcutta, and it is said that her commander, Captain Johnson, received $50,000 for taking her out. She was of 470 tons burden,—smaller than the Robert Fulton, but larger than the Savannah,—and sailed from Falmouth August 16, 1825. Like the Savannah, her engine was only worked when the weather was fine, it being used 64 out of the 103 days required to perform the passage.

A steamer of 350 tons, called the Curacoa, built in England for a company of merchants of Amsterdam and Rotterdam, ran between Amsterdam and the Dutch West Indies for some time in the later twenties. The Meteor, a British steamship, ran between England and the Mediterranean in 1830; she carried the mails.

Following the Savannah, the next steamer to cross the Atlantic was the Royal William, a 363-ton ship, constructed in Quebec. She made the run from Quebec to London in something over 40 days, leaving August 5, 1833, and reaching Gravesend September 16.

One of the most famous of the early steamships was the Sirius, a small, but stanch, vessel that was sent from Queenstown to New York by the British and North American Steam Navigation Co. on a regular line that had just been established. She left on her voyage to New York on April 5, 1838, with forty-six passengers, and reached her destination April 23. Later in the same day the steamship Great Western arrived from England, and the appearance of these two vessels in the harbor caused great excitement in New York. The Great Western had left Bristol on April 7, thus making the passage in 15½ days as against the 17 of the Sirius. The Sirius had originally been built for coast-wise service in England, but had been chartered in order to anticipate the Great Western, which was about ready to sail on her first trip. The Sirius made two round trips in the line, and was then placed on the route between Dublin and Cork, where she continued plying until January 16, 1847, when she was wrecked. The British Queen, newly built, took the place of the Sirius when she left the transatlantic route.

Another Royal William, built by W. & J. Wilson, at Liver-



THE BRITANNIA, FIRST REGULAR CUNARD LINE STEAMSHIP, 1840.

Length 207 feet; tonnage 1135; the Acadia, Caledonia and Columbia were sister ships.

BRITISH SCREW STEAMSHIP GREAT BRITAIN, 1845.
First iron transatlantic steamer: 3270 tons

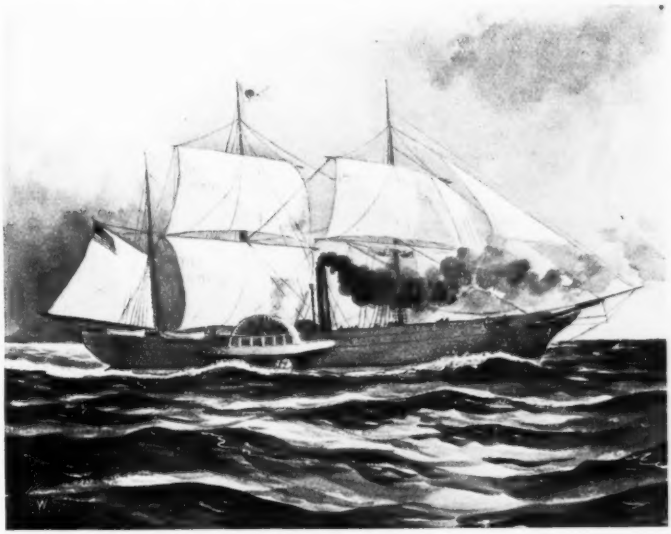
pool, with engines by Fawcett, Preston & Co., left Liverpool July 5, 1838, with passengers for New York. She had water-tight compartments,—probably the first boat so equipped. She made several voyages, and was then succeeded by the Liverpool, a steamer of 1150 tons, constructed by Humble & Milcrest, with engines of 468 horse-power, by Forrester & Co. The company operating her was known as the Transatlantic Steamship Company, and was capitalized at £800,000. The Liverpool went on the line to New York in October, 1838. A few voyages only had been made when she was purchased by the Peninsular & Oriental Steamship Co. and her name changed to Great Liverpool.

The Great Western continued to run for several years, making thirty-seven round trips before she ceased plying to the port of New York. She was sold in 1847 to the Royal Mail Line, and was broken up in 1856. The British Queen, the first of the British & American Steam Navigation Company's own steamers, left Portsmouth, England, on her maiden voyage to New York on July 12, 1839. A companion steamer, the President, came out the next year, and in 1841 was lost at sea; the British Queen was then sold, and thus the company that held the honor of having sent the first regular passenger steamer to America from Great Britain passed out of existence.

The Great Britain, the first large screw steamer and the first Atlantic steamship of iron, was launched in 1843, but did not cross the ocean until 1845. She made a number of voyages, and was then placed in the Australian service, her rig being changed.

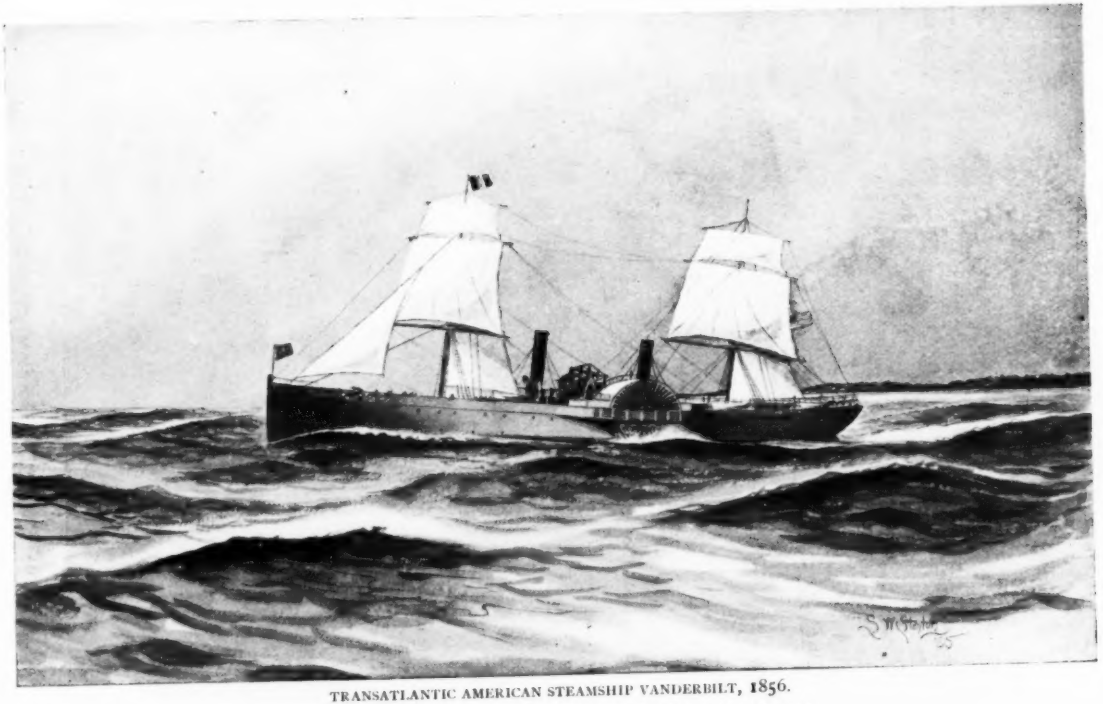
In 1840, Mr. Samuel Cunard, who had gone to England from his native town in Nova Scotia, organized the British & North American Royal Mail Steam Packet Co., the members of the company consisting of himself, George Burns, David McIver, and others. A mail contract between the company and the British government, at £60,000 annually, was no small help to the new concern, which at once ordered four new side-wheel steamships to ply between Liverpool, Halifax, and Boston. Before they were finished, however, the small steamer Unicorn, a Canadian-built vessel, was taken across, and then dispatched to Boston, where she arrived June 2, 1840. The Britannia, the first of the regular Cunarders, was ready soon after, leaving Liverpool on Friday, July 4, 1840, and arriving at Boston, *via* Halifax, on the 19th of the same month. Soon after, the Acadia, Caledonia, and Columbia, boats identical in all particulars to the Britannia, were placed on the line. These vessels plied only to Boston during the first years of their existence, but later a line was run to New York.

After the Savannah, the first American transatlantic steamship was the United States, built in 1846 by William H. Webb, at New York. She made but one round trip, being sold to the Prussian government



AMERICAN STEAMSHIP UNITED STATES, BLACK BALL LINE, 1847.

Ran between New York and Liverpool; 268 feet in length; 2000 tons.



TRANSATLANTIC AMERICAN STEAMSHIP VANDERBILT, 1856.

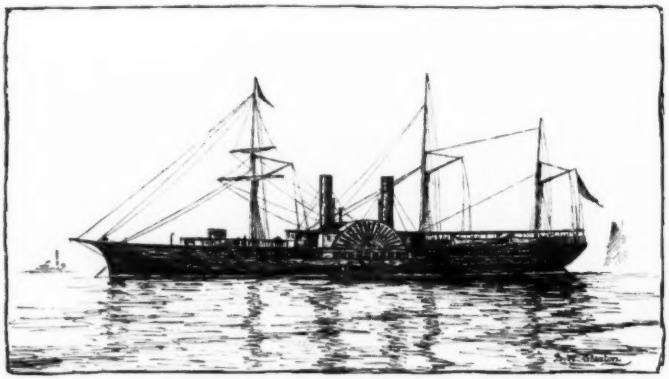
The fastest ocean steamship of her time; 331 feet in length; 3360 tons.

AMERICAN STEAMSHIP ADRIATIC, OF COLLINS LINE, 1856,

The largest and finest ocean steamship that had ever been constructed; 4144 tons.

to be used as a steam frigate. Following this boat, came the Hermann and Washington, which were built in 1847. They were constructed to ply between New York and Bremen. The Franklin (1848) and Humboldt (1850) were built for the New York and Havre Steam Navigation Co., an American line, and received $150,000 per annum from the United States government for carrying the mails. Both of these vessels were lost; they were succeeded by the Arago, 2260 tons, and Fulton, 2300 tons,—both fine ships.

The most important line of American transatlantic steamships established during these earlier days of steam navigation was the famous Collins Line, Mr. E. K. Collins, proprietor. Four splendid steamships were contracted for, and the government agreed to pay the new line $385,000 subsidy and $415,867 for carrying the mails, on condition



AMERICAN STEAMSHIP ILLINOIS, 1851.

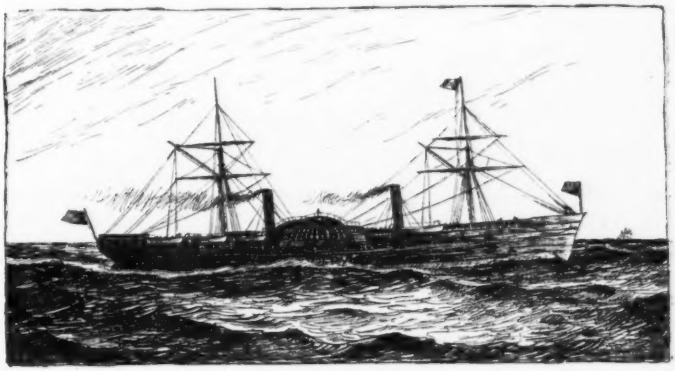
Of New York and Central American Line; 267 feet in length; 2100 tons.

that the vessels of the line should eclipse in speed the steamers of any other line. By the end of 1850 four of the finest steamships that had ever been built were in operation, and had at once come to the fore in the matter of speed. These noted vessels were the Atlantic, Pacific, Arctic, and Baltic, each of which cost over $700,000. They were more completely and beautifully finished and furnished than any steamships that had heretofore crossed the Atlantic, and were soon the favorite ships running between America and England. At this time the Cunard Line was receiving, each year as "subsidy," from the British government $735,000, which was raised in 1852 to $866,700, in addition to which the mail pay amounted to over $700,000 annually. The Collins Line received a subsidy of but $385,000 from

the United States government, and a few years later even this was withdrawn, which action, coupled with the loss of the Arctic and Pacific, ruined the company, causing the Collins Line to go out of existence.

The Arabia (1854), of the Cunard Line, was the first of the transatlantic liners to possess but two masts. This vessel was a very fine craft, built to eclipse the records held by the Collins boats, but she failed in this particular, although she was of very fair speed.

A celebrated steamship was the Golden Age, a side-wheel beam engine New York-built steamer of 3000 tons that crossed the Atlantic in 1853. She had accommodations for one thousand passengers, and was magnificently fitted up. From England she went to Australia, making the quickest passage on record. From Sydney she ran to the



AMERICAN STEAMSHIP ARAGO, 1855.
Of the New York and Havre Line; length 292 feet; 2260 tons.

Isthmus of Panama in 39 days. The Yankee Blade, 2200 tons, an American steamship, made the run in 1854 from New York to Panama (*via* the Straits of Magellan) in 47 sailing days,—the fastest on record to that time.

In 1850 the Liverpool, New York and Philadelphia Steamship Co. (afterwards known as the Inman Line, and now the American Line) was organized, and placed two steamers, the City of Glasgow and City of Manchester, on the line between Liverpool and Philadelphia. It was an age of wooden, paddle-wheel steamers, but the proprietors of this line were far-seeing, practical men, and tried the experiment of making their first two vessels iron screw steamers. The City of Manchester, the second of the fleet, sailed from Greenock for Belfast on her

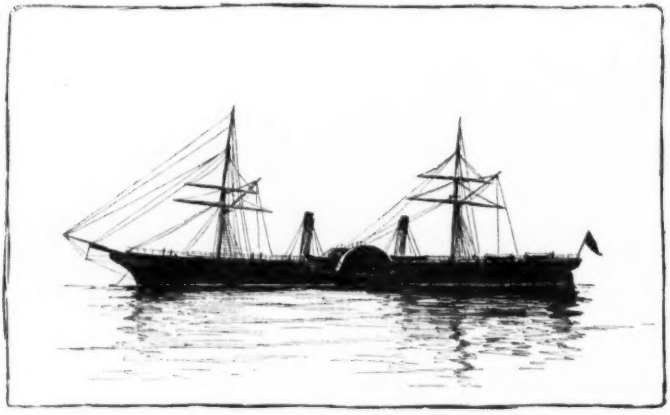
PROMINENT EARLY OCEAN STEAMERS.

Name.	Tonnage.	Year Built.	Where built.	Length; breadth; depth in feet.	Engines. Diameter of cylinders and piston stroke in inches.	Route, etc.
Savannah (Am.)	380	1818	New York.		Inclined, direct acting, paddle; 40×72	First steam vessel to cross the Atlantic, 1819.
Robert Fulton (Am.)	750	1819	"		Cross head, paddle.	New York, Cuba and New Orleans steamship.
Royal William 1st (Can.)	363	1831	Quebec.	160×28×17½	Side lever, paddle.	Second steam vessel to cross the Atlantic
Sirius (Br.)	703	1836	Leith.	170×25½×18¾	" " 60×60	First regular transatlantic passenger steamer.
Royal William 2d (Br.)	617	1837	Liverpool.	145×27×17½	" " 48½×66	Built to run between England and America.
Great Western (Br.)	1340	1837	Bristol.	236×35½×23¼	" " 73½×72	Built for Liverpool and New York trade.
Liverpool (Br.)	1150	1838	Liverpool.	210×36×21	" " 75×72	Name afterward changed to Great Liverpool.
British Queen (Br.)	1863	1839	Blackwall.	275×37½×27	" " 74½×72	Built for Liverpool and New York line.
President (Br.)		1839	"		" " 81×72	Built for Liverpool and New York line.
Britannia (Br.)	1135	1840	Port Glasgow.	207×34.2×22.4	" " 74½×82	First regular Cunard Line steamship; Liverpool and Boston.
Acadia (Br.)	1154	1840	"	207×34.2×22.4	" " 72½×82	Cunard Line.
Caledonia (Br.)	1138	1840	"	207×34.2×22.4	" " 72½×82	"
Columbia (Br.)	1175	1840	"	207×34.2×22.4	" " 72½×82	"
Great Northern (Br.)		1842		274×37×15	Screw.	Coastwise.
Great Britain (Br.)	3270	1843	Bristol.	322×48×31½	Screw; 80×72	First iron screw steamship.
Queen of the East (Br.)	2618	1839	England.	270×45×30	Paddle; 84×108	Iron; England and Calcutta.
India (Br.)	1200	1839	"	200×40		Built for India Steam Navigation Co.
Hibernia (Br.)	1422	1843	"	219×35.9×24.2	Side lever, paddle; 77½×90	Cunard Line. Liverpool and Boston.
Cambria (Br.)	1422	1845	"	219×35.9×24.2	" " 77½×90	Cunard Line. Liverpool and Boston
United States (Am.)	2000	1847	New York.	256×50×30½	" "	New York and Liverpool.
Washington (Am.)	1700	1847	"	230×39×31	" " 60×120	New York and Bremen.
Hermann (Am.)	1800	1847	"	235×40×31	" " 60×120	" "
America (Br.)	1825	1848	England.	251×38×25	" " 72½×82	Cunard Line.

Niagara (Br.)	1825	1848	England.	251×38×25	Side lever, paddle; 72½×82	Cunard Line.
Europa (Br.)	1834	1848	"	251×38×25	" " 90×96	"
Canada (Br.)	1831	1848	"	251×38×25	" " 90×96	"
Franklin (Am.)	2400	1848	New York.	263×41×26	" " 81×84	New York and Havre; wrecked 1854 on Long Island.
Ohio (Am.)	2397	1849	"	248×45½×24½	" " 90×36	New York and Central America.
Georgia (Am.)	2695	1849	"	255×49×25½	" " 90×36	New York and Central America.
Atlantic (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Converted into sailing vessel.
Arctic (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Sunk by collision, 1854; 562 lost.
Pacific (Am.)	2860	1849	"	290×46×32	" " 95×108	Collins Line. Lost in 1856.
Baltic (Am.)	2860	1849	"	290×46×32	" " 95×120	Collins Line. Changed to sailing vessel.
Humboldt (Am.)	2850	1850	"		" " 96×	New York and Havre line; cost $560,000; lost near Halifax in December, 1853.
Asia (Br.)	2226	1850	England.	266×40×27	" " 96¼×108	Cunard Line.
Africa (Br.)	2226	1850	"	266×40×27	" " 96¼×108	"
Illinois (Am.)	2100	1851	New York.	267×40×31	Two, oscillating, paddle; 85×108	New York and Chagres.
City of Glasgow (Br.)	1609	1851	Glasgow.	237×34×25	Screw; 71×60	First Inman Liner; screw; Glasgow and Philadelphia. Lost 1854.
Samuel S. Lewis (Am.)		1851	Philadelphia.	225×32×27	" 60×40	Built for Boston and Liverpool trade; afterward went to Pacific, where she was wrecked.
Arabia (Br.)	2402	1852	England.	285×40×27½	Side lever, paddle; 103×108	Cunard Line.
J. L. Stephens (Am.)		1852	New York.	280×40×26	Oscillating, sidewheel; 85×108	New York and Aspinwall.
Golden Age (Am.)	3000	1853	"	270×43×24½	Vertical beam, sidewheel; 83×144	New York and Australia.
Yankee Blade (Am.)	2200	1853	"	275×32×22	" " 75×132	San Francisco and Panama; wrecked Oct. 1, 1854.
North Star (Am.)	2000	1853	"	269×38×29½	Two, vertical beam; 66×120	Built as steam yacht for Com Vanderbilt; then transatlantic steamship.
Candia (Br.)	2200	1854	England.	281×40×29½	Screw; 70×48	Liverpool and Alexandria
Fulton (Am.)	2061	1855	New York.	290×42×31½	Two, oscillating; 65×120	New York and Havre Line.
Arago (Am.)	2260	1855	"	292×40½×31	" " 65×120	" "
Persia (Br.)	3300	1855	England.	376×45×29	Side lever, paddle; 100½×120	First Cunard steamship of iron.
Vanderbilt (Am.)	3360	1855	New York.	331×47½×32½	Two vertical beam engines; 90×144	New York and Havre. Fastest ocean steamer that had ever been built.
Adriatic (Am.)	4144	1855	"	345×50×33	Two, oscillating, sidewheel; 100×144	Collins Line. Largest ocean steamer when she first appeared.

trial trip on July 16, 1851, and averaged 13 miles an hour on the run, the engines—two, driving a double-bladed screw—making twenty-five revolutions a minute. The Samuel S. Lewis, built the same year, in Philadelphia, for the Boston and Liverpool line, was a screw steamer, the propeller of which—14 feet in diameter, with four blades—made one and three-fourth revolutions to one of the crank shaft. In 1852 the Peninsular and Oriental Company adopted the screw on two of their steamers,—the Chausan, of 775 tons, and Formosa, of 675 tons, these boats being attached to their Chinese local trade. These were followed by the Bengal, 2185 tons, and Candia, 2200 tons, for the Indian ocean trade.

The Persia, the first iron steamship of the Cunard Line, was contracted for in 1855, to compete with the Adriatic, then building for the Collins Line. She was 380 ft. in length and of 3870 tons, and was a very handsome and beautifully-fitted steamer. After she appeared, the Adriatic, 4144 tons, was completed, and she is acknowledged to have been the finest that had ever been built. She was the last steamer built for the Collins Line, which went out of existence shortly after her advent. Commodore Vanderbilt established a line of steamers to Southampton and Havre from New York in 1855, putting on the steamers North Star, Ariel, Ocean Queen, and Vanderbilt. This latter, the largest beam engine steamship that had ever been built up to that time, was the fastest ocean steamship of her time. She ran from New York to the Needles, Isle of Wight, in 9 days and 8 hours, and made the passage westward in 9 days, 9 hours, and 24 minutes.



BRITISH STEAMSHIP PERSIA, 1855.

First iron steamship of the Cunard Line; 3300 tons; 376 feet in length.

Following is a summary of the prominent ocean steam lines in 1855:

Liverpool and New York.—Collins Line: Atlantic, 2860 tons; Pacific, 2860 tons; Baltic, 2860 tons; Adriatic [building], 4144 tons; paddle steamers. Cunard Line: Persia, 3300 tons; Africa, 2226 tons; Asia, 2226 tons; Europa, 1834 tons; paddle steamers.

Liverpool and Boston.—Cunard Line: America, 1825 tons; Arabia, 2402 tons; Canada, 1831 tons; Niagara, 1825 tons; paddle steamers.

Glasgow and New York.—Scotch Line: Edinburgh, 2500 tons; New York, 2150 tons; Glasgow, 1962 tons; screw steamers.

London, Cork and New York.—Cork Line: Minna, 1300 tons; Brenda, 1300 tons; screw steamers.

New York and Havre.—Arago, 2260 tons; Fulton, 2061 tons; Union, 2000 tons; Ariel, 2000 tons; North Star, 2000 tons; Vanderbilt, 3600 tons; paddle steamers. Ericsson, 1800 tons; screw steamer.

Antwerp, Southampton and New York.—Belgique, 2590 tons; Constitution, 2500 tons; Leopold I, 2500 tons; Duc de Brabant, 2500 tons; Congress, 2500 tons; screw steamers.

New York, Southampton and Bremen.—Washington, 1700 tons; Hermann, 1800 tons; paddle steamers.

Liverpool and Philadelphia.—City of Baltimore, 2367 tons; City of Washington, 2380 tons; City of Manchester, 2109 tons; screw steamers.

Thus, in 1855, paddle-wheel steamships predominated in ocean service, but a reaction in favor of the screw was about to take place. It was at this time that Great Britain was beginning to attain a degree of perfection with the screw that rapidly proved the superiority of this mode of propulsion for ocean steamers, and after the Persia and Adriatic,—crowning efforts in the way of paddle steamers,—new steamers, with few exceptions, were provided with screws.

SURVEYING AND MAPPING A CITY.

By C. H. Rice.

IF, after buying a wagon-load of coal and storing it in his cellar, the lucky buyer should find that it had turned to gold, he presumably would not go to the coal-dealer to have it weighed to determine how much it was worth. The reason is as plain as a pike-staff. But the same man apparently is perfectly content to hold city real estate of enormous value, the title for which is founded in records prepared by methods which were scarcely accurate enough to justify their use in describing land worth 50 cents per front foot.

For examples to illustrate the considerations set forth in this paper, two cities will be used,—*viz.*, Baltimore, Md., and Roanoke, Va., both of which in times past presented good (or, rather, bad) examples of how confusion may become worse confounded in consequence of inadequate maps and records, but both of which have set other cities in like condition a good example by causing accurate maps and records to be prepared.

Baltimore was laid out many years ago, while Roanoke has grown into a city within the past few years. The records of Baltimore are a perfect tangle by reason of many imperfect copies made from originally imperfect descriptions scattered over many years. It is a singular fact, well illustrated by the condition of affairs in Baltimore, that municipal authorities will take the utmost pains and spare no expense in filing an enormous number of deeds, so that they can be found and consulted with the least possible trouble; but it never seems to strike them that it would be well to discontinue the practice of taking their gold to the coal-dealer to be weighed.

Inaccuracies in land-surveying result from many causes. The chain or tape may not be the length it is assumed to be. Even when its true length under given conditions is known, it may be elongated by excessive tension, and shortened by sag if too little tension is used; and it expands or contracts with every change of temperature. Minor sources of error may be ignored when coal is being weighed, but, if gold is the substance, it is usual to put the scales in a glass case, make them of the best obtainable material, and use them with every possible precaution against inaccuracy.

In measuring city property, worth many dollars per front foot, the first requisite is a standard of known length. At Roanoke the standard is a tape 300 ft. long, which has been verified by comparison with a 300 ft. tape the length of which was carefully determined by the

Missouri river commission. The comparison of the two tapes was made by measuring with each two base lines about 3000 ft. long, carefully taking account of the various conditions of support, tension, temperature, etc.

The standard of length for Baltimore is a line on Mount Royal avenue 500 ft. long, with permanent marks set at convenient intervals. The distances between these marks were measured by a United States Geodetic and Coast Survey assistant engineer with a secondary base apparatus. With this standard, all tapes used on the Topographical Survey of Baltimore are compared. The man who is content to have the coal-dealer weigh his gold will no doubt think that the length of a tape, when accurately known, ends all difficulties, but he who is accustomed to weighing gold knows that even with fine, accurate balances many precautions and safeguards against error are necessary.

In accurate surveying the most essential safeguard against error is a well-arranged triangulation system. When properly connected, with lines and angles measured with tape and transit, such a triangulation system enables the computer to say that "these lines and angles have been determined to such and such a degree of accuracy"; "no error exceeding the set limit of error has occurred"; or, if such an error has occurred, "it is in this line or that angle."

In constructing a triangulation system only a few lines—frequently only one—are directly measured, all the others being calculated from the one or more which have been measured by solving the several triangles of the system. The length of the bases, or measured lines, is therefore a matter of prime importance. The bases at Baltimore, two in number, were measured with a tape 300 ft. long, supported on pulleys at intervals of 20 ft. The pulleys were hung on wooden supports carefully set on line and grade. The tension was measured by spring balances, and the temperature read at three different points on the tape every time it was suspended. The constants for the tape—its length at a standard temperature (62° F.), rate of expansion per degree of temperature, etc.—were determined by many comparisons with the Mount Royal standard. During the comparisons the tape was suspended and used in every way as it was when the bases were measured. The work was done at night, in order to reduce the temperature correction to as small a quantity as possible. Each base line was about 7000 ft. in length.

The measurement of the angles of a triangulation system is a matter second in importance only to the measurement of the bases. With the best of instruments and the most painstaking of observers angles can be only approximately measured. But, by measuring the angles many times and in certain ways, values with a very small

amount of error can be arrived at by refined methods of computation.

The intersection points of a triangulation system are too far apart for direct use in surveys for the determination of property lines and the solution of other similar problems. If only a topographical survey, such, for example, as the survey of St. Louis, is desired, the map-work may be founded directly upon a properly-devised triangulation. In such surveys as those of Baltimore and Roanoke the triangulation needs to be supplemented by many additional points, the locations of which are determined therefrom by direct measurement. In order that the check upon these direct measurements furnished by the triangulation may be placed at a high figure, the distance between the triangulation points becomes a matter for careful consideration. Experience at Baltimore and Roanoke indicates that 3000 ft. is a practical average.

If to the triangulation and traverse systems above mentioned a system of precise levels is added, a foundation for every kind of mapping and calculating is established. If proper precautions are taken for preserving the marks, this foundation remains good for all time. The matter of preserving the marks is a somewhat expensive one. At Roanoke granite monuments, with a copper wire leaded in for the mark, were buried deep enough to escape the possible influence of frost. At Baltimore stone monuments, asphalt blocks, and iron pipes have been used, besides many surface-marks upon sidewalks and curbs.

The character of the superstructure to be built upon the above-described foundation depends upon the use for which it is intended. In a great city it ought to provide for all the multitudinous requirements of complex public and private interests.

The city of Roanoke was confronted with the all-important problem of adjusting property and street lines, and hence the maps were drawn on a large scale and the field-work was executed by methods enabling all the intricate calculations necessary in effecting such an adjustment to be made.

At Baltimore the same complex problem is again present, and many additional ones as well. A large territory has been annexed to the original city, and its system of streets must be projected to the best possible advantage. A sewerage system adequate to the needs of a great city must be designed. A basis for the records of the various branches of the city government must be provided, and the general public must be enabled to procure the various maps which the requirements of trade, comfort, and luxury demand.

The maps ordinarily needed by any city, and the uses to which they may be put, will be somewhat as follows:

First. A general map, embracing the entire city, on a scale of about 500 ft. to one inch, showing horizontal contours at intervals of 5 ft., streets and their names, blocks and their numbers, the various political and governmental districts, public and important private buildings, and lines of transportation and travel.

Upon this map the broad, general lines for public improvement may be projected,—such as streets, sewers, etc. It will serve the various branches of the city government for an index. For example: the water board can use it to show the general location of water mains, fire hydrants, etc. Corporations, such as gas, electric, and street-railway companies, will make much the same use of it. It will serve the general public as a wall map. Such a map will be the last one to be prepared, because it is, in fact, a compilation from all the others.

Second. Maps on a scale of 200 ft. to 1 in. should cover about 1 sq. mile for each sheet. They should show horizontal contours at intervals of 5 ft.; all streets and alleys; all buildings and fences; and the conditions of the ground,—whether wooded, grass, or cultivated.

Upon the separate sections of this map the details of street locations and drainage problems can be more closely studied than upon the general map. If the contours are as well-located as they have been at Baltimore, reasonably accurate profiles may be prepared from them.

The general public will use a great many copies of this map. Every real-estate owner ought to possess the sheet upon which his property is located. From such a map the owners of large tracts, handsomely laid out, like many in the annexed district of Baltimore, may have relief models prepared, thus enabling the landscape gardener to study methods of improving and beautifying their grounds to far better advantage than by any other means. A few relief maps of this kind have been prepared at Baltimore, and their striking beauty and utility is apparent to every one who sees them.

Third. Maps on a scale of 100 ft. to 1 in. may be conveniently made to embrace ¼ sq. mile (at Baltimore $\frac{1}{16}$ of a sq. mile is the size used). Nearly everything upon the surface of the ground should be shown, to say nothing of much that is underground,—such as sewers, gas and water mains, electric conduits, etc. Most engineering problems may be worked out in detail with the assistance of such maps. The various departments of the city government will have occasion to use them constantly. As an example, the street department can show the character and condition of the pavements in different streets, the date and by whom laid, and much other information of like character,—matters constantly wanted by committees of city councils, contracting firms, or private individuals.

Fourth. Maps on a large scale (40 ft. to 1 in. as used at Baltimore and Roanoke) cannot, of course, cover a very large territory without becoming unwieldy. Twenty-four sheets to the square mile has been found a convenient size. The dimensions of blocks might be allowed to determine the matter, by so arranging the sheets that complete blocks would always be shown on each sheet.

Such maps ought to contain everything a map can be made to show, even to the ground-plans of buildings, materials of which the buildings consist, number of stories, and owners' names.

At both Baltimore and Roanoke the information for compiling these maps has been taken in such a way that all kinds of calculations may be made from them. The relation between the boundaries of properties as they actually exist on the ground, and as they exist in the descriptions given in deeds, may be worked out, and the information to be used by the proper legal authorities in adjusting such matters may be presented in the best and most accurate way. The objection has been raised that such information will unsettle many titles, and promote litigation. The idea upon which this objection is based is erroneous, since a title under an existing wrong description is necessarily unsettled, while a proper adjustment of the discrepancy will settle it.

If a piece of cardboard be assumed to represent a block of city property, and this be cut up into small pieces with a sharp knife to represent the lots, everything can readily be fitted together without gaps or overlaps. This is a case parallel to perfect deed descriptions. If, now, the shape and size of each separate piece be distorted by stretching, contracting, and warping in every conceivable way, the conditions as they often exist in the deed descriptions will be presented. Of course the sections will not fit together.

The problem of adjusting erroneous boundaries is one of the most complex and intricate that can well be conceived of. In many cases the most proper course is to accept the lines as shown on the ground, and prepare new descriptions to fit the facts, regardless of the old descriptions. A mutual confirmatory agreement among owners will make such an adjustment a perfect one. In writing deeds it is a general custom to avoid one source of inaccurate descriptions by calling for natural objects. As long as the natural object exists, or its location can be found, this is all very well; but, after it is lost, and every deed which corners upon it gives a different location for it when run out by the surveyors, then the trouble commences. Until some broad scheme for general adjustment is devised and carried out, errors once started constantly tend to accumulate and go from bad to worse, until, as at Baltimore, there exists a condition of apparently hopeless confusion. The

descriptions are copied from one deed to another by lawyer's clerks, with whom the only question is one of title, not whether the description is a correct one or not. What matters it to them if the recorded description of some adjacent lot covers part of the land conveyed by the one just written? There may be a profitable case in it for some brother lawyer, if it gets even that much thought.

In many cases the original muddle has been greatly aggravated by city officials, who, when retiring from office, claim the notes taken during their incumbency, as private belongings, thus robbing the public of what is really its own property. Instances are far too frequent in which employees of the city government have prepared notes, as an example, of the location of sewer connections, and have claimed the notes as their own, not even furnishing the city with a copy. The mischief possible in a few years by such gross dishonesty is very great, and in many instances there is no way in which adequate punishment can be meted out to the evil-doers. Such troubles arise in a large measure from a lack of system and proper records. With maps and records as outlined in this paper, and a proper system of keeping all records up to date in the various departments of city government, all such difficulties would be avoided.

The filing and indexing of maps and notes is a matter of detail which requires more careful attention than it usually receives The mass of information collected during a survey is so great as to be perfectly bewildering unless systematically indexed and filed. At Roanoke the maps and notes are in charge of the city engineer, and are filed in a fire-proof vault in metallic cases built especially for them, so that everything is easily kept in its assigned place and may be found at any time without trouble.

The survey of the city of Baltimore, which has been so frequently referred to, is still in progress, with Col. H. T. Douglas, M. Am. Soc. C. E., as chief engineer.

The sum of $125,000 was appropriated at the outset for this work. The city council has recently passed another appropriation for $31,000, to continue the survey another year. The chief engineer estimates that still another appropriation of like amount will be necessary before the maps and notes can be considered ready to be turned over to the proper department of the city government and made a matter of public record. When the work of this survey is fully completed, Baltimore will have a set of maps and accompanying records second to those of no city in the world.

REVOLUTION IN STEEL-MAKING.

By William Metcalf.

WITHIN little more than a century all steel, except a little Wootz, was made from wrought iron by what is known as the cementation process, and its uses were limited. Early in the last century Huntsman invented the process of producing steel by the fusion of wrought iron and blister steel in crucibles, the product being known as crucible cast steel. This product was so superior that the use of steel was increased greatly, and all wants seemed to be supplied. For about 100 years there was little or no advance in the art of steel-making, except in increased skill and accuracy, and improved machinery. During this time the production of cast iron and wrought iron had increased enormously; the invention of railroads, iron ships, and iron bridges caused an immense demand for wrought iron in all forms, especially in heavy plates and beams, which was well and promptly met and filled by skilled manufacturers in Europe and in the United States.

The advances made in the use of iron were so great and so rapid that the time covered was known, popularly and properly, as the "Iron Age." The art of iron-making had reached its limit both in quality and in magnitude of pieces, since all iron was produced primarily in little balls that could be handled by one man, and these had to be piled and pasted together piece by piece, until the size required was reached, the size being necessarily small because of the mode of working.

No one seemed to expect much advance, and no one appeared to think of any advance in steel-making until the demands of war, requiring heavy guns, led a genius, now Sir Henry Bessemer, to conceive the idea of producing cast steel in large masses by blowing air through molten cast iron. About the same time another genius, Sir Wm. Siemens, invented the regenerative gas furnace,—an invention of importance hardly exceeded by that of Watts and certainly not by that of Bessemer.

A Frenchman named Martin adapted the Siemens furnace to the melting of steel in bulk, the product being known first as Siemens-Martin steel; in the last few years this name has been replaced by that of "open hearth steel." In this way the world was given two new products,—bessemer steel and open hearth steel, which in 30 years have led to such enormous advances in the use of metals and in the power of engineers that the time is well named the Age of Steel and the *generation of revolution.*

With the demands were found the men,—men of genius, skill, and energy, many of whom, like Holley, Jones, and others in our own country and in England, shortened their lives in the intensity of their efforts to keep in advance of all demands: they have done their work and made for themselves imperishable records, while the world, greatly benefited by their efforts, moves on to greater achievements.

It is the object of this article to explain as well as may be, not the relative merits of these steel processes with a view to invidious comparisons, but the different fields of usefulness which each may be expected to occupy, each being adapted best to its own field.

Before proceeding, it is important to explain that all of the constituents of steel are named in hundredths of 1 per cent., the rule being, except in a few special steels not under consideration here, and in very high carbon steel, that no element of steel save iron is present in greater quantity than 1 per cent.; in fact, all except carbon and manganese are present in quantities of less than 1/10 per cent. So that .10 carbon, .10 phosphorus, etc., mean 1/10 per cent., and the term "point" means 1/100 per cent.; in speaking of differences of points of carbon, for instance, twenty-five points means 25/100 per cent., and so for all of the elements.

Although bessemer steel was invented primarily to produce large masses of steel for heavy ordnance and for armor, failure in that direction was as ignominious as was the failure of the instigator of the invention, Napoleon III, to establish imperialism: the invention itself, however, was so simple, and its potencies were so great, that men of skill and energy in all industrial countries took up the process, and by persistence overcame in a few years the chief difficulties first met with.

The one crowning success of bessemer steel was, and is, the production of strong, practically homogeneous, and durable steel rails. It is well understood and acknowledged generally that to the bessemer steel rail is due the great advance in railroad practice, resulting in more powerful engines, larger and more comfortable cars, increased speeds, greater safety, and much lessened cost. The higher speeds and heavier engines required stronger boilers in the engines and stronger bridges to carry the heavier loads. This demand was met in a measure by the iron makers, and in a still greater degree by the bessemer steel makers, but neither were entirely satisfactory. It was difficult to make iron of the necessary strength, ductility, and soundness, especially for boiler plates; and, while bessemer steel could be made with these necessary properties, numerous failures, mysterious at the time, led cautious men to be fearful of adopting the new material. In this emergency crucible steel was tried for boiler plates with complete success, but the cost of the material was so great that persistent

efforts were made to find a cheaper satisfactory material. This was found eventually in open hearth steel, and so the open hearth process scored its first great victory and came into prominence. Those crucible steel-makers who from excess of caution had refrained from building boiler-plate mills were undisturbed, and those who had been progressive enough to build such mills promptly supplied themselves with open hearth furnaces to produce their ingots.

During this time there had been many applications for bessemer steel as material for bridges, ship and tank plates, and machinery parts. This field was occupied so completely that in a few years iron bridges and ships were hardly thought of, except by a few ultra conservative people; and, in regard to machinery, it became a fact that mowing machines, for instance, which a few years before contained but one piece of steel, all other metal parts being iron, now contain but one piece of iron, all other metal parts being steel.

In the beginning the bessemer process experienced a succession of disastrous failures which almost led to its abandonment. It was soon discovered that neither phosphorus or sulphur were reduced in this intense burning process; both of these elements, contained in the cast iron, remained in the steel. This difficulty was removed by the use of iron low in phosphorus and sulphur, the limit for phosphorus being fixed at .10; so that what is now known as bessemer pig is iron guaranteed not to contain more than .10 phosphorus. The limit for sulphur is that it shall be so low as not to cause red-shortness, and manufacturers may be depended upon to attend to this, as no mill man wishes to be annoyed with red-short material.

An insufficiency of heat was another serious trouble, which was overcome by an increase of silicon content, as it was found that the combustion of silicon produced intense heat; a farther advantage was found in the fact that high silicon tended to low phosphorus.

The greatest difficulty of all, perhaps, was the presence of large quantities of oxids, which remained in the steel, producing excessive red-shortness and general badness. This was overcome by the introduction of melted ferro-manganese after the blowing was completed, the manganese taking up the oxygen sufficiently to leave the remaining steel workable and good.

These chief difficulties having been removed, the advance in the production and use of bessemer steel was marvellous,—unparalleled in the history of industrial arts. Still there were startling and apparently mysterious failures that frightened the timid, until experience gave knowledge, and knowledge guided the skilful and careful makers to better work, so that the failures became rare, confidence was assured, and both makers and users felt safe within well-established limits.

The chief limitation to the bessemer process is in the entire absence of power to manipulate beyond very narrow limits, for the reason that, when a heat is blown, the sources of heat are exhausted, and the steel must be put into ingots before it becomes too cold. If it be overblown, the excess of oxids cannot be eliminated; if it be underblown, or if it be a cold heat, there is no means of increasing the temperature; if it be "wild," sufficient time cannot be given to allow it to settle, for it cannot be "killed"; and, if steel be not practically killed in the melting, the resulting ingots will be as porous as a sponge —honeycombed. Notwithstanding, the bessemer process is simple, efficient in good hands, and very cheap; it has its great field of usefulness, and it has come to stay. Good, mild bessemer billets, stronger and tougher than the best wrought iron, have sold lately for less than $16 per ton of 2240 lbs. Makers of wrought iron need no farther hint than this.

Basic bessemer steel led to the belief for a time that the field for the product would be widened greatly, and it has been enlarged greatly by enabling the English and continental makers to utilize their phosphoric ores; but the quality of the basic is not so much better than the acid as to have made much change in the use of the product. It is very different with the basic open hearth product.

In using the basic bessemer process it is necessary to continue the blow a few moments after the carbon is burned out, and this "after-blow" is liable to be carried a little too far, causing burning of iron and excess of oxids; the process, too, is subject to the same limitations regarding the power to manipulate as is the acid process, and therefore the general application of bessemer steel has not been widened greatly by the invention of the basic process.

The open hearth process was now established firmly, supplying excellent boiler plate, sheets, and all manner of mild steel for many purposes. It also became useful in the production of a good quality of steel castings. This latter industry alone has become a great boon to engineers, supplying them with strong, tough castings of almost any desired shape, overcoming many troubles which had been caused by the weakness of cast iron and the expense of difficult shapes in forgings. The sand bottom, or acid process, was subject to the same limitations as the bessemer acid process, chemically speaking; neither phosphorus or sulphur were reduced, only silicon and carbon being subject to modification at will.

This made it necessary to insure that the charge should contain only so much phosphorus and sulphur as were allowable in the finished steel. Aside from this, nearly all of the troubles known in the bessemer process disappeared in the open hearth; the source of heat

in the open hearth being extraneous, temperatures can be increased or decreased at will. If, when a heat is melted, it be not just right, it can be held in the furnace indefinitely,—cooled down, made hotter, or held even, as may be desired. The steel may be melted dead, so as to remain quiet in the molds and make sound ingots or castings. The carbon, silicon, and manganese contents can be controlled thoroughly in mild steel, and there need be no over-melting or burning.

In high carbon steel there seems to be more difficulty in producing uniform results, so that for some years bessemer steel held the preference for steel for springs, battering tools, etc.

The open hearth is a much slower process than the bessemer, and for a large output requires a rather larger investment and more skilled labor than the bessemer; therefore it does not seem likely to drive the bessemer from its own peculiar field.

The basic process, so successful in the bessemer, is even more so in the open hearth, for, the source of heat being extraneous, it is not necessary to introduce phosphorus in the open hearth as a fuel; and it is found also that phosphorus may be reduced considerably before the carbon is burned out, so that it is possible to produce steel of 1 per cent. carbon or more from a charge containing .10 phosphorus, and have the steel contain less than .05 phosphorus, although it be melted down only to 1 per cent. or more carbon, requiring practically no recarbonizing. This fact has given the basic open hearth an enormous field of usefulness which was not successfully occupied by the bessemer.

It is possible in the basic open hearth to melt down to any desired carbon, and not go any lower, so that there need be no over-melting in any case, if ordinary care and good judgment be used.

Sulphur is not yet reduced in the basic open hearth, and it is necessary to start with low sulphur in the charge. The reduction of sulphur ought not to be an insoluble problem, and here is a field in which the coming generation of metallurgists may exercise their skill.

Armor plates, great guns, large structural shapes, and heavy castings are now made by the open hearth process to meet all reasonable requirements. Common cutlery, files, cheap hatchets, good battering tools (such as hammers and sledges), springs, and tire of all sorts are now made almost exclusively of bessemer or open hearth steel, the advantage in uniformity and strength being rather with the basic open hearth. At the time of the invention of the bessemer process all of the articles mentioned in the last sentence, and many more, were made of crucible steel, or of German steel; and although now, as always, crucible steel of inferior chemical quality is stronger and better in the tempered condition than the best of bessemer or open hearth steel, yet

the latter, being much cheaper and generally good enough, have almost entirely supplanted crucible steel for all except high-class tools.

A few years ago there seemed to be a wide gap between crucible steel and the ordinary bessemer or open hearth steel, to be filled by something better in quality than the latter and less in cost than the former.

A careful inquiry over the whole field both in America and Europe, and a careful consideration of the opinions of many of the leading steel-makers of the world, led a prominent firm of crucible-steel-makers to decide upon and build a three-ton bessemer plant, as the bessemer seemed to them more likely to fill the gap than the open hearth. The basic open hearth was not then developed by Americans, although used largely for the common grades by Europeans. The plant was built at an expense of about $80,000, and started. Inside of a month another prominent steel-maker laid down in the yards of the crucible men billets of very high quality at a price less than the cost of the raw material that would have been required in the bessemer to produce billets of even quality. These were basic open hearth billets, the process having been developed while the little bessemer was building. The bessemer plant was shut down immediately, but the $80,000 was not all lost; the vessels were torn out and sold as scrap, cranes were shifted, new ladles and pits were arranged, a small basic open hearth furnace was built, and now the little plant is running successfully. The "gap" has been filled to the entire satisfaction of consumers, and crucible steel is relegated to the higher walks, where the requirements of great strength, fineness, and endurance outweigh questions of cost.

The fact remains hardly disputed that crucible steel of chemical inferiority, but of rather high carbon, is, in the tempered condition, greatly superior to the best of bessemer or open hearth steel; this is not a mere mystery; it is not due to ghosts or to hobgoblins; it has certainly a discoverable and removable chemical or physical cause. It seems now almost certain that it is due to one or all of the three elements, oxygen, nitrogen, and hydrogen, all of which are introduced in steel in the bessemer and open hearth processes in much greater quantities than in the crucible process. It is known that they are there either as elements, or as oxids, cyanogen, or ammonia; in what way they produce bad effects, or how they may be removed, is not known. Here is a large field for metallurgic engineers. Other great revolutions may come at any time and in ways as entirely unexpected as many of the great changes of the past.

The conclusions from what has been written may be summed as follows:

1. Wrought iron can never again be a leading metal of construction, since a stronger and better material can be produced at much less cost than is possible to the laborious hand-worked system of making wrought iron; all men should rejoice if mankind could be released forever from the heavy, exhausting labor of the puddler.

2. The field of the expensive crucible has been narrowed greatly, and limited to the finer requirements of the arts; it will hold this field until future developments shall remove the last elements of weakness from the cheaper processes; when that time comes, crucibles will be used no longer for making steel.

3. The bessemer process is so exceedingly simple, handy, and cheap that it does not seem likely that the open hearth process will ever drive it out of use or prevent its development.

4. The open hearth process, and especially the basic, is so well in the front as to certainty and quality, and it is so economical, that it must be given precedence, and engineers may feel easy as to their ability to get almost anything they need.

5. Poor crucible, bessemer, and open hearth steel will always be produced in large quantities, and buyers will be found for them as long as greed and ignorance are to be found among men; and there will always be men of conscience who, with a due regard for character, will do the best possible work. The wise investor and sensible engineer will know these latter, and those who will may have good material and be safe in using it.

Revolutions sharp, sudden, expensive, and unexpected, have been so numerous in the last 30 years that the men who have led in the struggle have become gray at a time when ordinarily much of the spring of youth, and all the vigor of prime, should still be left to them; many have fallen by the way side, and many are gone over to the great majority; they have done their work, and they have done it well; the foundations are established so firmly that the ordinary works of to-day would have been wonders 30 years ago, and wild speculations of dreamers 50 years ago; the achievements of the next century will be established on these same foundations; art, skill, and science will beautify the superstructures, and the workers will look back with admiration upon the records of the pioneers.

The art of steel-making is so well established now that engineers and investors can go on with their work safely and economically, and it seems as if all requirements were met so well that there might be a period of rest from revolutions, and that leaders could devote themselves to the perfection of organization and the production of sure results. Those who are in the front, however, see clearly that much is yet to be done, and they are not so optimistic as to look for quiet times.

ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT.

By C. R. McKay.

THE adverse financial conditions which have prevailed during recent years have cut with peculiar keenness into the profits of the silver mining industry, and those mines which can now be profitably worked are exemplifications of the survival of the fittest. Their vast mining and milling plants call for the exercise of almost all branches of science and engineering. Probably no mine system in the world possesses more features of interest and instruction than the Ontario and Daly mines, worked in conjunction under one ownership, and located near Park City, Utah, in the Wahsatch range.

The recent completion of the Ontario drain tunnel and the utilization of its waste water to furnish electric light and power for the numerous works and mills of the companies present some features which seem to justify description, and which may convey valuable lessons to those engaged in similar projects.

The Ontario mine was discovered in 1872 and has been continuously worked since that time, its owners having purchased and acquired a vast amount of land for the purpose of extending their territory and controlling the ore bodies along the veins therein.

The Ontario has four vertical shafts, only two of which are at present actively used, the several shafts having been sunk in order to reach the ore bodies in the most convenient and economical manner. The shafts now used are No. 2 and No. 3, the former being at present 1500 feet in depth and the latter 1100 feet. The underground workings of these mines have attained such vast dimensions that, if placed end to end, they would form a continuous tunnel nearly 60 miles long.

The chief difficulty and expense encountered during the operation of this mining enterprise has been the disposition of the water which pours into the underground excavations from subterranean reservoirs and streams. Two means only existed by which this could be controlled, these being the continual operation of large and numerous pumping engines, and the cutting of tunnels from the lowest available point of the workings to some surface location which afforded natural drainage for the final disposition of the flow. Either method, of course, involved great expense.

When Ontario shaft No. 3 had reached a depth of 600 feet, the quantity of water had become so formidable that considerations of economy impelled the management to run a drain tunnel from the bottom of that shaft to a point nearly a mile distant, through which the drainage was carried off. For several years this tunnel proved equal to the requirements and resulted in great saving to the company, but, as the shafts went deeper and the lateral workings extended, the water again became an intolerable burden, and far more serious than ever before, for at this time the Ontario was operating much deeper than any of the surrounding mines, and the ramifications of its underground work had assumed such proportions that not only had the local water greatly increased, but the mines located round about, and in fact the entire neighboring country, had begun to drain into the lower workings of the Ontario. In one case a large adjacent mine which had been unable to contend against the water, and had been closed down on that account, became absolutely dry and remains so to-day.

When the Ontario had reached a depth of 1200 feet, it became necessary to run a new drain tunnel, and to locate it at a depth sufficient to provide for extensive operations in the future.

The topography of the country is such that the utmost thought and careful consideration were demanded in finally deciding as to the direction of the proposed tunnel and the location of its mouth. The estimates as to time and expense involved were most difficult to form, and the conditions involved were complicated and uncertain. The decision, as finally made, was to run eastward from the 1500-ft. level of No. 2 shaft, the total length of the tunnel being approximately 3 miles. It was expected that 6 years would be required to complete the work, and that the cost would approximate $500,000.

Work was begun on this tunnel July 25, 1888, at the east end. The first 300 ft. were driven entirely by hand, during the erection of machinery at the mouth of the tunnel. The plant consisted of boilers and engines, a Root blower, used as an exhaust for sucking foul air and powder smoke from the face, two large air compressors supplying Ingersoll drills, and a saw-mill for cutting timbers used in the tunnel. All the timber was hauled by wagon from 15 to 20 miles, being shaped and fitted at the tunnel mouth.

During November, 1891, a tremendous body of water was encountered, which drove out the men from the face. Bulkheads were useless. Nothing could restrain the flow, and all that could be done was to wait for the water to exhaust itself. The volume was so great that for a distance of 9000 ft. the track had to be raised, because of the insufficient water way, and parts of the track were entirely washed out. Seventy-one days were lost before work at this point could be resumed.

Again in May, 1892, a similar experience stopped all work for 55 days. These two occurrences were preceded by the loss by fire of the buildings at the mouth of the tunnel, which caused a further delay of 2 months for reconstruction. The total loss of time during the construction of the tunnel, from all causes, amounted to 413 days.

In order to relieve the water pressure along the main line of the tunnel, side drifts, aggregating 644 ft., were run at various points. Ten switches for the passage of trains were also cut double the normal width of the tunnel, making a total length of 1593 ft. of additional work.

Owing to the nature of the ground along the line of the tunnel, it was considered impracticable to sink an intermediate shaft, but, in order to hasten the work, a force of men was set to drive eastward from the 1500-level of No. 2 shaft, the idea being to push forward until the two headings should meet. After running 270 ft., a flow of water was encountered which bade fair to endanger the entire mine by flooding the pumps; therefore work was discontinued at the west end. After more than six years of unremitting labor, mishap, and disaster, the final connection of the two headings was made on the night of October 7, 1894. The east and west headings of the tunnel coincided perfectly as to alignment and grade, and daylight was visible 3 miles distant from the bottom of shaft No. 2.

The total cost of this improvement amounted to $466,753. This shows the average cost per foot for the total length of 15,494 feet to have been $30.12. During the last year of the work a total advance of 1654 feet was made, the average cost per foot for that distance being $48.82. The annual saving due to cessation of pumping amounts approximately to $164,000, at which rate the tunnel will pay for itself within 4 years. One-half of the cost of this work was paid by the Daly, whose drainage is discharged through this tunnel.

As the tunnel neared completion, it became evident that the flow of water therefrom would be permanent and of considerable amount, though no means existed by which the normal flow for the future could be accurately foretold. However, the quantity of water handled by the pumps during past years was known with reasonable accuracy, as was also the decrease in that quantity due to the approach of the face of the new drain. Measurements of the flow at the tunnel mouth had been made from time to time, and comparison of these various sets of figures gave some indication as to the future discharge, and showed that opportunity existed for securing additional conveniences and economy by utilizing the water at the tunnel mouth, where a short and steep fall was readily available.

The idea of electrically transmitting this waste energy to those dis-

tant points where it could be usefully applied was adopted by Superintendent R. C. Chambers, and the matter of designing and constructing a suitable plant was referred to the writer.

Surveys and measurements made at this time, while the tunnel was yet several hundred feet from completion, showed a steady flow of water amounting to about 800 c. f. per minute and an available fall close to the tunnel mouth of 125 ft. in 380 ft. The general opinion was that a decrease would take place in the near future, but many facts and figures convinced the engineer in charge of the work that a permanent increase would occur in the flow at the mouth. Accordingly a plant was decided upon of sufficient capacity to furnish light to all of the hoisting works, mills, and dwelling-houses belonging to the Ontario and Daly mining companies, and sufficient power during the day to drive the machine shops of the mines and mills. No underground lighting was attempted.

The choice of a route for the transmission line lay between an overhead line, following a well-traveled road through cañons for a maximum distance of about 6½ miles, and an underground line through the tunnel, to a point well adapted for a center of distribution, and offering advantages in saving of copper and ease of inspection.

The overhead route was considerably the longer, involved a somewhat wider distribution of load along the main line, and exposed the line to extremely heavy winter weather and to frequent and severe storms during summer. This route was easy of inspection throughout, except in winter weather.

The underground route presented the advantages of a shorter line, greater facilities for uniform voltage throughout the system, and absolute protection of the transmission from bad weather and lightning; the entire main line, too, could be inspected and repaired by a workman without dismounting from a tram-car. On the other hand the cost of erection and danger of accidental contact were greater, and the maintenance of proper insulation of the line seemed impossible, owing to the floods of water falling from the roof and timbers of the tunnel, the frequent shifting and breaking of timbers, and the great number of insulating supports required for mechanical strength. Therefore the overland route was chosen for the transmission.

The hydraulic plant is located about 1600 ft. from the mouth of the drain tunnel. The water is conveyed through a wooden flume and ditch to a pressure tank, there being also an overflow ditch with adjustable gate for disposing of surplus water. The pressure tank is provided with a settling compartment and racks for catching drift contained in the water. From the pressure tank is led a wrought-iron pipe of varying diameter.

The prime mover is a 3-ft. Pelton tangential wheel calculated to deliver on the main belt 90 h. p. when running at 280 revolutions per minute under 120 ft. effective head.

The conditions to be fulfilled in the selection of a type of electrical equipment for this plant removed all direct current systems from consideration. The choice lay between the various alternating single and multiphase systems, generating the maximum line voltage directly, and supplying reducing transformers at various points along the main line. The Monocyclic system was adopted by reason of great simplicity of the system as a whole, its freedom from lack of balance between the different circuits, the ability to successfully operate self-starting motors of a simple and well-tried type, as well as arc and incandescent lights, and, finally, its first cost, which in this case was less than for any other system excepting the three-phase

The electrical equipment of the power house includes an eight-pole, 60-kilowatt, Monocyclic alternator, driven at 900 revolutions by a twelve-inch belt from the pulley on the wheel shaft. This dynamo at no load generates 2200 volts at 60 cycles per second, and normal excitation is supplied by an Edison bipolar shunt machine driven from the alternator shaft. The dynamo is over-compounded to furnish 2500 volts with a full load current of 25 amperes.

From the terminals of the generator three main leads are taken to a skeleton switchboard, on which are located switches, rheostats, indicators, lightning arresters, and a gage indicating the pressure of the water supplied to the wheel below. All wiring between the dynamo and switchboard is carried beneath the floor of the dynamo room on porcelain insulators in plain sight. The engineer has full control of the entire system without leaving the side of the switchboard.

The transmission line covers a total distance of 6½ miles, and traverses a very rough and broken country, rising at one point to nearly 9000 ft. above sea level. The entire line, however, was located so as to obtain good sun exposure at all times. The poles are of red pine. The loss in the transmission at full load was calculated at about 11 per cent. between the power house and the centre of distribution.

The insulation resistance of the system is remarkably high. The total number of 16-c. p. lamps connected with the system is 700, all supplied at 110 volts. The problem of securing proper distribution of light in the various mills and hoisting works was very successfully solved by a suitable arrangement of the incandescent lamps. The arc lights formerly in use were very unsatisfactory, being difficult to maintain, owing to constant exposure of their mechanism and to clouds of metallic dust and steam, and especially objectionable because of localizing the light and casting numerous dense shadows.

The wiring and fixtures in the mills are subjected to very unfavorable working conditions. The most objectionable feature is the effect of metallic dust, steam, and sulphuric acid vapors upon exposed metal surfaces, and upon the insulation of the wire. Frequent testing has failed, however, to indicate any grounds or short circuits. Hard rubber water-proof sockets are used throughout the mills, and the lights are tapped directly on the supply branches without rosettes, the branches being protected by switches and cut-outs in sheltered places.

There are three motors connected to the system, two of 15 h. p. each and one of 25 h. p. The 15-h. p. motors drive the machine shops of the Marsas Mill and the Ontario Mine; the large motor is located in the saw mill at Ontario No. 3 shaft.

On February 24, 1895, the plant was started. A trial run failed to develop any defects throughout the entire installation. On the following day, during a heavy storm of snow and sleet, the entire load of lamps connected with the system was thrown on. The performance, under load, of the installation in the power house was thoroughly satisfactory. The dynamos ran smoothly and quietly, and failed to show any evidence of heating in any part. This lack of heating has characterized their performance at all times since the beginning of operations.

The method of furnishing excitation to the generator in a plant of this character is a factor of vital importance in securing close regulation. It may be stated as a general rule that, where the normal field strength of the generators is a function of their speed, close regulation of voltage for large and rapid fluctuations of load is impossible to attain in a water-power plant.

To insure constant excitation the exciting machine should always be driven by a separate water wheel, where the conditions permit of such arrangement.

The plant has run constantly since its completion without interruption or repairs of any sort, barring the breakage of the exciter shaft by a tight belt shortly after the start. The accident caused interruption of service for 12 hours only, and was purely a result of carelessness. During the month of June some interesting experiences occurred with lightning. On one occasion an electric storm of great intensity prevailed along parts of the line most distant from the power house. During the space of a half hour no less than thirteen separate strokes of lightning came into the switchboard from the main line, all of these being successfully discharged by the arresters. The final discharge, however, was of such severity as to start an arc between the discharge points of the arresters on the two main wires. This arc of comparatively low resistance immediately short-circuited the dynamo through a portion of the large copper strip used as a ground connection, and

the machine ran in that condition for fully 10 seconds before being disconnected. No damage whatever was sustained by the dynamo. The two arresters, however, were rendered absolutely useless, the brass discharge knobs being completely melted down, and several were fused together. After removing the damaged arresters, the dynamo was again started, and no further difficulty was encountered.

Two engineers are employed to operate the Ontario electric system, each of whom runs the plant 12 hours daily. No labor is involved, and, owing to the steadiness of the load both day and night, the attention required in the power house is limited to the inspection of oil in the various bearings and the starting and stopping of the plant at the beginning and end of each run, at which time the machinery is wiped off. The motors require no attention during their operation. The entire system at any instant involves only the attendance of the engineer at the power house, who also makes any slight repairs or alterations required from time to time throughout the distribution. The operating expenses therefore practically include only the engineer's pay, occasional minor supplies, and lamp renewals.

The total cost of the Ontario system is a matter of gratification when viewed in comparison with recent figures showing cost of similar installations elsewhere, and in view of the diversity of service and economy of attendance secured. The saving effected by the installation is somewhat difficult to estimate accurately because of the large additional service hitherto unpossessed by the company. The interest account is somewhat higher than that charged against the old arc light plant. The labor account for the service now rendered by the present plant is very considerably reduced, some income is already derived from the sale of current for lighting, and the amount saved annually in fuel and illuminating oil exceeds $3000.

The great drain tunnel is being extended through the Ontario ground to the Daly mines, and a continuation of work has resulted in a notable increase in the flow of water available at the power house, the amount being at present about 1500 cubic feet per minute.

Negotiations are nearly completed for doubling the installation at the power house, with the object of providing a reserve unit in case of break down, and of selling current by contract to a local organization for lighting and incidental power service in Park City.

The extension of the plant will involve but comparatively small outlay and labor, and the attendance will not be increased.

It is, therefore, confidently expected that the plant will be made to earn dividends, in addition to furnishing its present service free of cost to the owners.

THE ARCHITECTURE OF MODERN HOSPITALS.

By E. C. Gardner.

LONG, long before "man's inhumanity to man" had been recorded in modern poetry, man's love for man had borne visible fruit in the shape of hospitals and asylums. There is good reason to believe that in the vast basin of the Nile there existed medical schools and institutions thousands of years before the beginning of the Christian era. There is believed to have been a hospital in Ireland 300 years B. C., and about the same time the great king of India, Asoka, ordered hospitals to be built throughout his kingdom. A famous Chinese traveller records a few hundred years later that "the nobles and landowners of India have founded hospitals in the cities, to which the poor of all countries, the destitute, the cripples, the diseased, can repair for shelter. They receive every kind of help gratuitously. Physicians inspect their diseases, and, according to their cases, order them food and drink, decoctions and medicines,—everything, in fact, that may contribute to their ease." The oldest hospital for women is said to exist in Siam. The ancient Greeks and Romans, from whom, or through whom, may be traced most of all that is called "modern civilization," maintained dispensaries and hospitals. Charlemagne and the Moors in Spain founded hospitals more than 1000 years ago, and it is said that during the thirteenth century there were nineteen thousand hospitals, or something that stood for hospitals, in Europe. Evidently the "Dark Ages" were not all darkness. In 1456 Francesco Sforza founded the great hospital in Milan which, with over two thousand beds, is one of the largest general hospitals in the world. Many hospitals existing in England were founded in the twelfth and thirteenth centuries, and the English have been founding others and making over the old ones ever since. The great London hospital of St. Bartholomew was established early in the twelfth century, and the hospital of The Holy Spirit at Rome, which in the seventeenth century had a revenue of $200,000, was begun in 1198.

All this and much more may be found in that book of wonderful research, "Burdett's Hospitals and Asylums of the World," but it is unnecessary to give farther examples to show that hospitals are not exclusively "modern" institutions. And yet the advance in medical and surgical science that has taken place during the last half century has been so great that the hospital planning, construction, and management considered wise and satisfactory two or three generations ago would now almost be thought detrimental rather than helpful.

Until within 100 years but little was known of the importance of cleanliness in the atmospheric and visible environments of the sick and wounded, although in the fourteenth century the Italians understood something of the nature of contagion, and attempted isolation on that account. The insane were treated almost as criminals, or, at best, as if they were to be blamed rather than pitied for their infirmity. All psychological influences, now recognized as of the greatest importance, were ignored and left to accident. Surgical operations were performed in the rooms containing the sick, and ventilation was so little comprehended that even in the early part of the present century one of the English

CANCER HOSPITAL, NEW YORK CITY—C. C. HAIGHT, ARCHITECT.

encyclopædias makes this astonishing suggestion: "When the ceilings of hospitals are low, it will be found wise to remove some part of them, to open the garret story. The doors and windows may likewise be opened. In winter the hospital wards are to be warmed with chimneys [sic] and never by stoves, for, though the latter may warm a large ward better and at less expense, yet by scarce making any draught of air they will be apt to increase its putrid quality"! And we are told that not so very much longer ago the physicians, in going their rounds among the patients, were obliged to carry scented handkerchiefs and various other refreshing stimulants to enable them to per-

ROOSEVELT HOSPITAL, NEW YORK CITY—R. M. HUNT, ARCHITECT.

form their painful duties without nausea or faintness. Now, as Dr. Weir Mitchell has said of a patient in a modern hospital: "If that sick boy were lord of a guinea a minute, no more could be known of his case, no more could be done for him."

All of which goes to prove that the world does move, even though on the old lines laid down in the beginning. Solomon might still declare that there is no new thing under the sun; but, if our new ways of doing the old things could have been tried on in Jerusalem, they would have made the Queen of Sheba dumb with amazement.

In a study of the planning and construction of hospitals the first step is to discover the ruling motive,—to answer the question, "Why?" The answer is easy. The center around which all else revolves, whether the hospital is to contain six, sixty, or six hundred patients, is the ward. This *is* the hospital. The administrative offices; the operating theaters; the heating and ventilating systems; the bath-rooms and reception-rooms; the home or training school for nurses; the store-rooms, dispensaries, kitchens, dining-rooms, and servants' quarters, whether the same be few or numerous,—all these are merely adjuncts to the ward. One perfect ward is the model for every other. It may be said almost without qualification that the one

essential of the perfect ward is cleanliness; not alone the visible cleanliness that results from washing with many waters and removing conspicuous dirt, but that more essential and immeasurably more difficult cleanness which protects from the germs of disease, bacilli, effluvia, odors, and emanations of all sorts. Even the site is determined by the requirements of the ward. It must afford ample light, security against noxious elements from outside, and opportunity to be, materially speaking, in the world, but not of it.

Assuming that there are money and land enough, it is hardly necessary to say that the site for a hospital should be chosen with special regard to its sanitary character; that it should be naturally dry and easy of drainage, both on the surface and underground; that it should have the most favorable outlooks, and be sheltered from the winds. It should likewise be of such extent that the noise and dust of crowded thoroughfares will not reach it,—a condition that will also allow the buildings to be placed with little or no regard to the "street front." As for shade trees, with all their beauty and charm, and their grateful effect, real and apparent, upon the summer air, it is rarely wise to choose a lot on account of the trees growing upon it. Compared with the life of the hospital, the tree is but a temporary affair, and there is no more common mistake than misplacing a build-

ADMINISTRATION BUILDING, JOHNS HOPKINS HOSPITAL, BALTIMORE, MD.

ROYAL VICTORIA HOSPITAL, MONTREAL.

MARY HITCHCOCK HOSPITAL, HANOVER, N. H.—RAND & TAYLOR, ARCHITECTS.

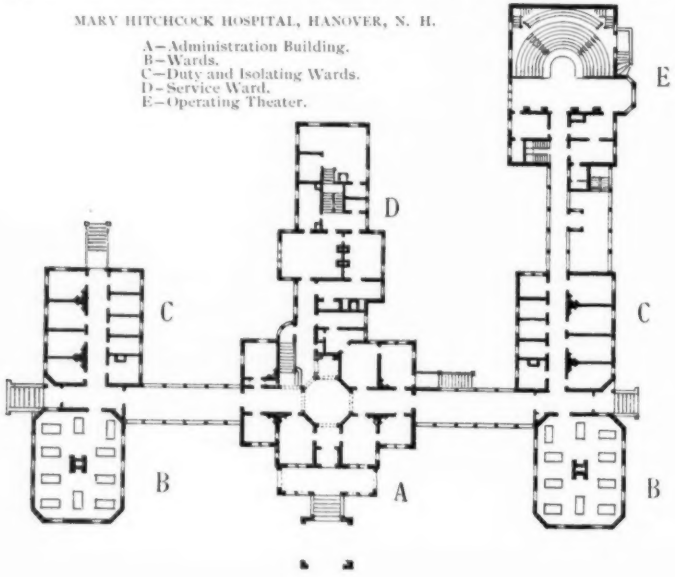
ing for the sake of sparing a tree that may be struck by lightning or palsy before the building is finished. It should also be remembered that 5 years—at the outside 10—will afford all the shade, all the verdant background, and all the shelter from pitiless winds that are necessary either for utilitarian or esthetic purposes. It sometimes happens that a natural slope in the surface of the ground may be employed in such a way as to seem to add to the excellence of the site. But this again, beyond what will ensure good surface drainage, is of little real importance, because, if a varying surface will allow a better adjustment of the floors, it can be easily obtained by grading.

It has been found in large cities that there is a marked increase of epidemic and contagious diseases in the immediate vicinity of hospitals where such diseases are treated, and this fact, with other considerations, has led to the building of new hospitals farther and farther from the centers of dense population, the great improvement in ambulances making the transportation of patients less difficult.

In some of the large cities of Europe it has been thought wise to go several miles towards, if not actually into, the open country. To diminish, if not actually remove, this danger of contagion, the expedient has been recently adopted in England of forcing the expelled impure air from the contagious wards through a chamber heated to

MARY HITCHCOCK HOSPITAL, HANOVER, N. H.

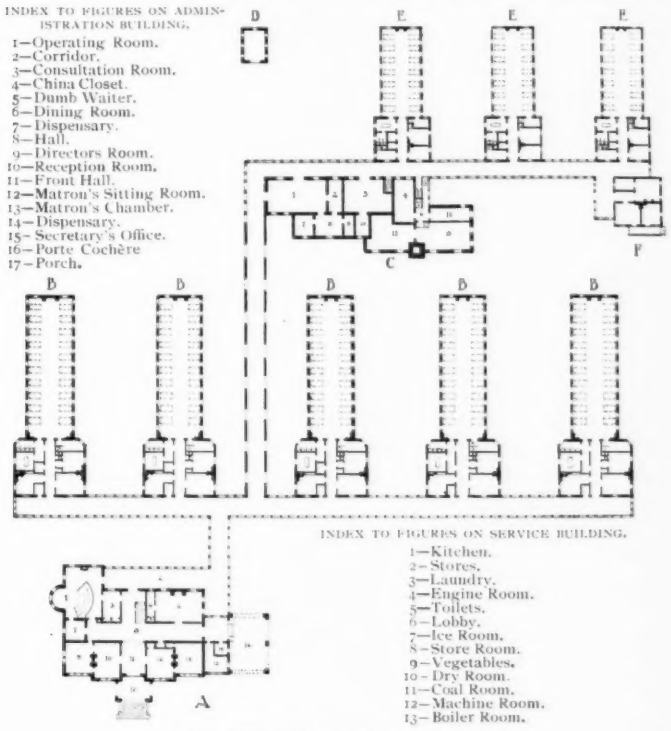
A—Administration Building.
B—Wards.
C—Duty and Isolating Wards.
D—Service Ward.
E—Operating Theater.



such a degree that all dangerous germs are destroyed. But this concerns ventilation and opens interesting speculations in other ways. We wonder whether the time will come when we shall set traps for dangerous microbes as we now do for mice, woodchucks, and bears.

Whether the plan determines the site or the site the plan, their intimate relation cannot be ignored, for, however uniform the needs may be, there is infinite variety in the details of their adjustment, and it would be practically impossible to find two sites so nearly alike that a plan adapted to one would, without modification, suit the other.

What is known as the pavilion plan is at present preferred for general hospitals. This means that each ward is wholly or partially



GRADY MEMORIAL HOSPITAL, ATLANTA, GA.

INDEX TO LETTERS ON PLANS.

A—Administration Building. B—Common Wards. C—Service Building. D—Mortuary Building. E—Colored Patients,—Common Wards. F—Colored Patients.—Administration Building.

A—MEN'S WARDS.

1—Drying Room.
2—Nurse (Isolating Ward).
3—Toilet (Nurse).
4—Bath (Medical Ward).
5—Medical Ward.
6—Sun Room.
7—Nurse (Medical Ward).
8—Toilet.
9—Toilet.
10—Nurse (Surgical Ward).
11—Bath (Surgical Ward).
12—Tea Kitchen.
13—Linen Closet.
14—Surgical Ward.
15—Sun Room.

B—ISOLATING WARD (MEN).

C—ADMINISTRATION BUILDING.

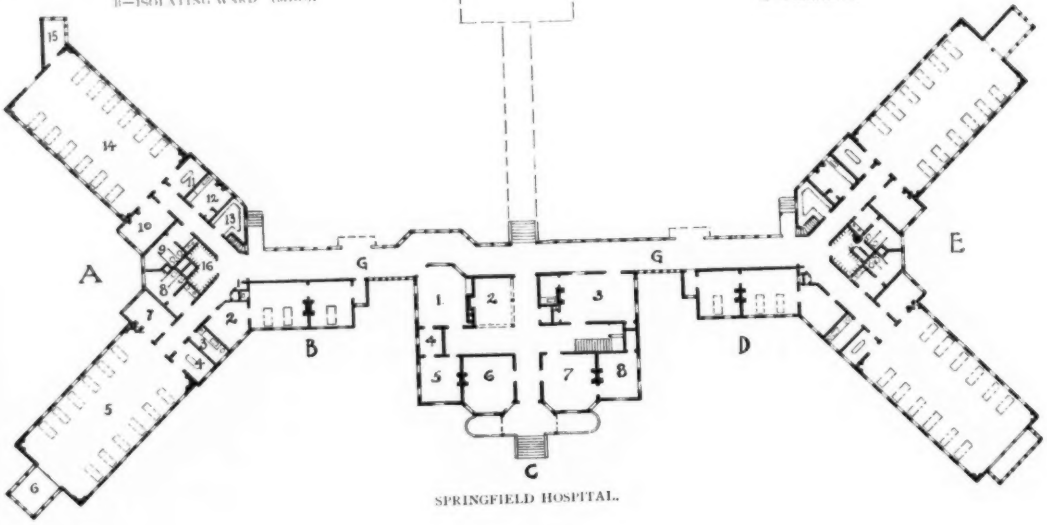
1—Operating Room.
2—Reception Room.
3—Dining Room.
4—Dispensary.
5—Consulting Room.
6—Board Room.
7—Matron's Room.
8—Matron's Bed Room.

D—ISOLATING WARD (WOMEN).

E—WOMEN'S WARDS.

F—KITCHEN AND SERVICE.

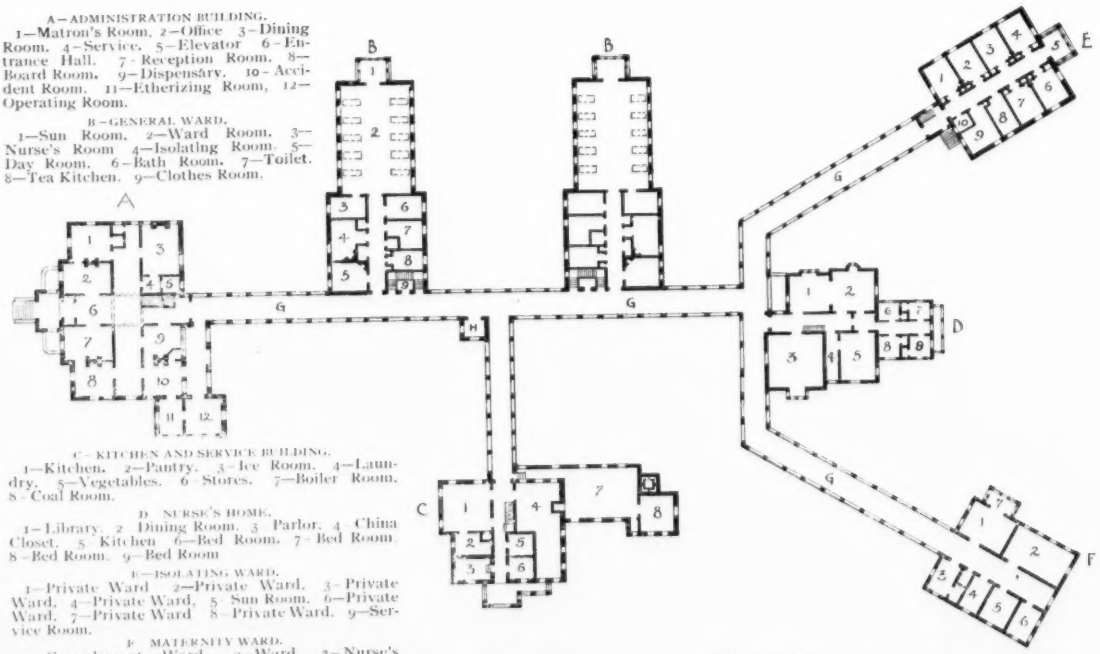
G—CORRIDOR.



SPRINGFIELD HOSPITAL.

A—ADMINISTRATION BUILDING.
1—Matron's Room. 2—Office 3—Dining Room. 4—Service. 5—Elevator 6—Entrance Hall. 7—Reception Room. 8—Board Room. 9—Dispensary. 10—Accident Room. 11—Etherizing Room. 12—Operating Room.

B—GENERAL WARD.
1—Sun Room. 2—Ward Room. 3—Nurse's Room 4—Isolating Room. 5—Day Room. 6—Bath Room. 7—Toilet. 8—Tea Kitchen. 9—Clothes Room.



C—KITCHEN AND SERVICE BUILDING.
1—Kitchen. 2—Pantry. 3—Ice Room. 4—Laundry. 5—Vegetables. 6—Stores. 7—Boiler Room. 8—Coal Room.

D—NURSE'S HOME.
1—Library. 2—Dining Room. 3—Parlor. 4—China Closet. 5—Kitchen 6—Bed Room. 7—Bed Room. 8—Bed Room. 9—Bed Room

E—ISOLATING WARD.
1—Private Ward 2—Private Ward. 3—Private Ward. 4—Private Ward. 5—Sun Room. 6—Private Ward. 7—Private Ward 8—Private Ward. 9—Service Room.

F—MATERNITY WARD.
1—Convalescent Ward. 2—Ward. 3—Nurse's Room. 4—Bath Room. 5—Private Ward. 6—Private Ward.

G—CORRIDOR. H—ELEVATOR.

BACKUS HOSPITAL.

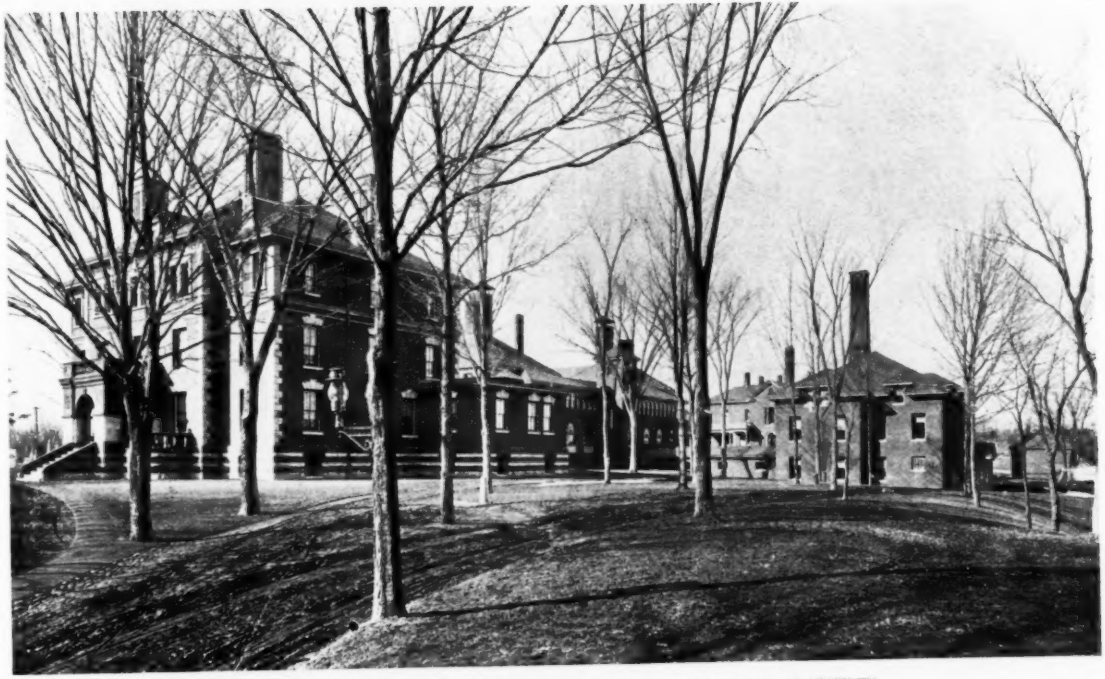
detached from every other, either in separate buildings or by means of semi-detached wings. In brief, there are two essential points to be gained: the fullest measure of convenience in passing from one ward to another, or from the administrative offices to the wards; and the desired isolation.

As a loss in one direction is a gain in the other, the adjustment of these two requirements varies according to circumstances. For instance: wards for contagious diseases of the milder types would demand greater sacrifices in the way of accessibility than would be desirable where the only need of isolation is to diminish as far as possible the objectionable consequences of assembling large numbers of sick or wounded people in close proximity. On the other hand, for actively contagious diseases more complete isolation must be secured at whatever sacrifice of convenient approach. When all has been done for cleanliness that can be done in the choice of the site, it remains to consider the building itself. In order to lay a broad foundation for perfect cleanliness, two things are needful,—simplicity and honesty.

It is probable that most of the hospitals that have been built in this country during the present century could be burned without any difficulty, and that most of those to be built in the next 25 years will also be contrived with reference to prompt and easy combustion if they should happen to take fire. And yet, unless distinctly intended to be destroyed, for sanitary reasons, as often as every 5 years, a hospital ought to be fire-proof,—not merely slow-burning, but proof against destruction by fire,—because of the helplessness of the occupants in case of fire, because it is easier to give to fire proof structures the qualities of cleanliness, immunity from constant repairs, and protection against noise, and because fire-proof means time-proof. It is one of the anomalies of our progressive age that so little is done to render all important buildings—public, commercial, and domestic—safe as well as durable.

"Fire-proof" means walls of masonry and floors and roofs of masonry or iron and masonry combined. It means that all flues for ventilation and warming are of the same incombustible materials; it allows, if it does not positively require, the wood used in the interior fittings to be reduced to the minimum. The outer wall will be double with a well-ventilated air space between the two shells of not less than 1½ in. The inner surface will be smoothly finished with cement, painted and varnished, and thus made practically impervious to moisture and dust. Something better than this may be devised, but, up to date, nothing seems safer, cleaner, and more durable. All sorts of tiles and glazed bricks have more or less cracks, and I am not aware that any so-called "glass" finish has been devised that is not liable to the same

CITY HOSPITAL, SPRINGFIELD, MASS.—E. C. GARDNER, ARCHITECT.



BACKUS HOSPITAL, NORWICH, CONN.—GARDNER, PYNE & GARDNER, ARCHITECTS.

GRADY HOSPITAL, ATLANTA, GA.

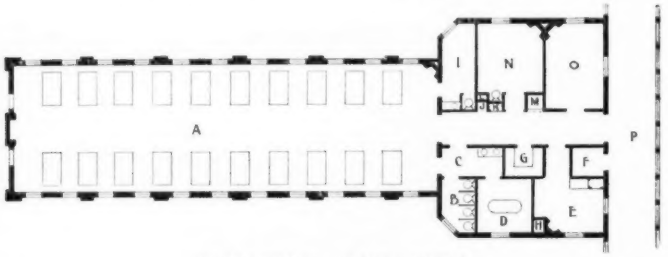
CIVIL HOSPITAL, VENICE.

fault. It is true that oil paint and the most durable varnishes available for this purpose are not absolutely impervious to hot soap suds and indiscriminate scrubbing, but there need be no indiscriminate scrubbing in a common ward, while the paint and varnish are easily renewed. Around the door and window openings there is no occasion for wood finish, or for stucco, cement, or marble "trim." Everything of that sort provides either fine cracks between the wood (or other material) and the surface on which it rests, or certain projections and hollows which afford resting-places for dust and whatever dust harbors. There will be no sharp angles to be abraded or filled with dirt, and, where the vertical walls join the floors, there will be a sufficient curve, either in the material of the floor or that of the wall, to allow easy and perfect cleaning. The ceiling will be treated like the walls in every respect except color. In brief, the inside of the ward will be as nearly as possible like a perfectly clean, smooth box, in which there are no rough places for dust to gather around and microbes to build their nests upon, no part which may not be reached by a damp sponge, and none which may not be kept so clean that it would not soil the fingertip of a white kid glove.

As every housekeeper knows, the part of the house most difficult to keep clean is the floor. In a hospital carpets would be absurd;

INTERIOR COURT, HOSPITAL OF THE INNOCENTS, FLORENCE, ITALY.

at the best they merely retain, and for a time conceal, the dirt that is sure to be present in them. Wooden floors made in the ordinary way have cracks especially contrived as fertile fields for the cultivation of microbes. Cement, even of the hardest, wears and produces a dust, all the more detrimental by reason of its fineness, and marble or burned tiles have both the dust and cracks against them, besides being hard and cold. Some durable, clean, elastic material of good color may yet be invented, but at present hard, fine-grained wood in the

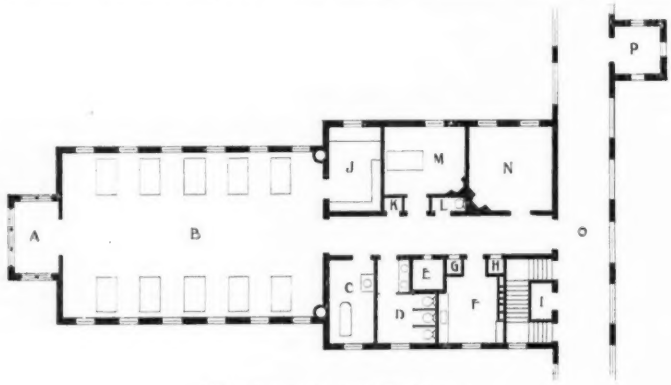


WARD BUILDING, GRADY HOSPITAL.

A—General Ward. B—Sanitaries. C—Toilet. D—Bath Room. E—Kitchen. F—Clothes Room. G—Linen Room. H—Vent. I—Nurse's Room. J—Stool Closet. K—Dry Room. L—Vent Shaft. M—Clothes Chute. N—Isolating Room. O—Dining Room. P—Corridor.

form of parquetry, or laid in such manner that there will be no cracks even after the lapse of years, appears to be the best thing for floors. A floor of this kind may be filled and coated in a way to make it practically impervious to dust and air, and, while not indestructible, it is subject only to light wear in the wards, and the coating of varnish or other protective is easily renewed. It has also the advantage of being a slow conductor of heat.

When all this is done, we have not achieved permanent cleanliness, but only provided the conditions that make visible cleanliness possible. Beyond that is the vastly more important demand for atmospheric purity. This requires the exclusion of dust from the outside,—the dust which so rapidly filters through common masonry, which

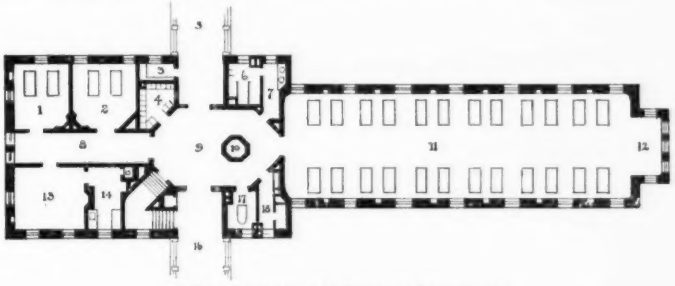


WARD BUILDING, BACKUS HOSPITAL.

A—Sun Room. B—General Ward. C—Bath Room. D—Toilet. E—Vent Shaft. F—Tea Kitchen. G—Dumb Waiter. H—Dumb Waiter. I—Clothes Room. J—Nurse's Service Room. K—Stool Closet. L—Water Closet. M—Isolating Room. N—Day Room. O—Corridor. P—Elevator.

laughs at lath and plaster walls and ceilings, and which rises through the cracks in the floors and crawls in around the window sashes. These are the foes from without. Those from within are the effluvia exhaled from the occupants, the impalpable dust that wears from clothing, bedding, and furniture, and the more evident sort that will still accompany footsteps, however well shod and shaken the feet may be that make them. Against the invisible dirt there is no protection but atmospheric washing,—that is, ventilation. Since all these impurities are constantly floating in the air, it follows that, if the air can be constantly expelled, these troublesome elements will also be cast out. And this opens the great question of pure air, and how to get it.

In practice outside air is supposed to be pure air, but this is only partially true; while artificial means may be employed for its purification, the obvious means of security against miasmatic or other prevalent atmospheric evils is the selection of a site naturally salubrious.

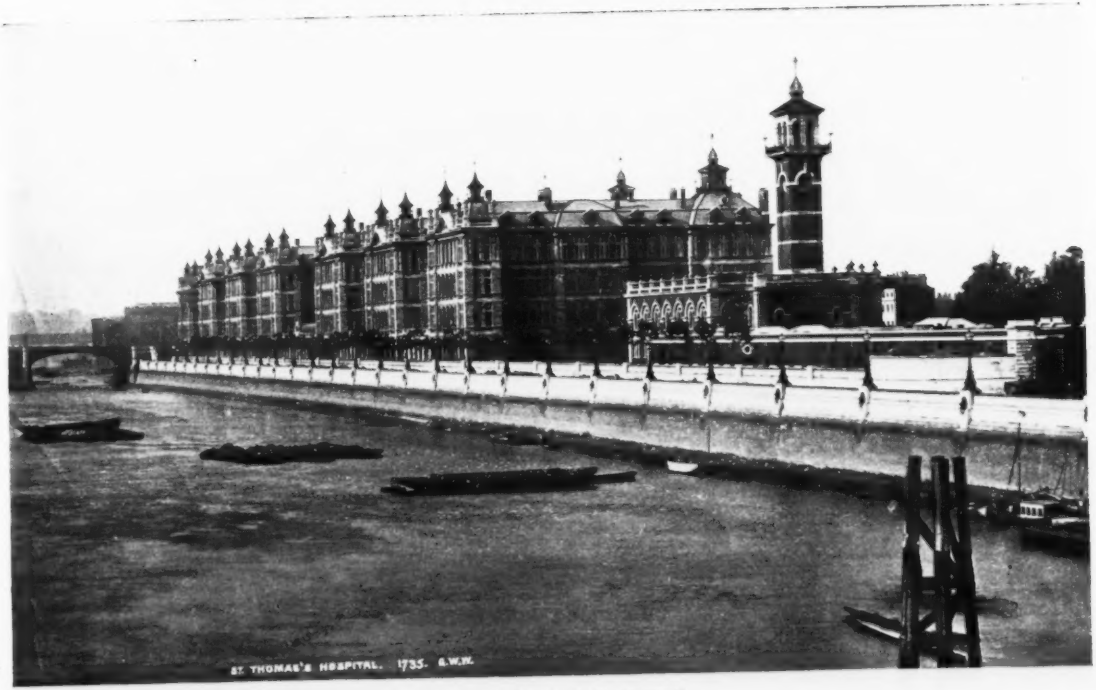


WARD BUILDING, JOHNS HOPKINS HOSPITAL.

1—Private Ward. 2—Private Ward. 3—Linen. 4 Patients' Clothes. 5—Connecting Corridor. 6—Water Closet. 7—Lavatory. 8—Corridor. 9—Central Hall. 10—Ventilating Chimney. 11—Ward. 12—Sun Room. 13—Dining Room. 14—Kitchen. 15—Lift. 16—Connecting Corridor. 17—Bath Room. 18—Nurse's Toilet.

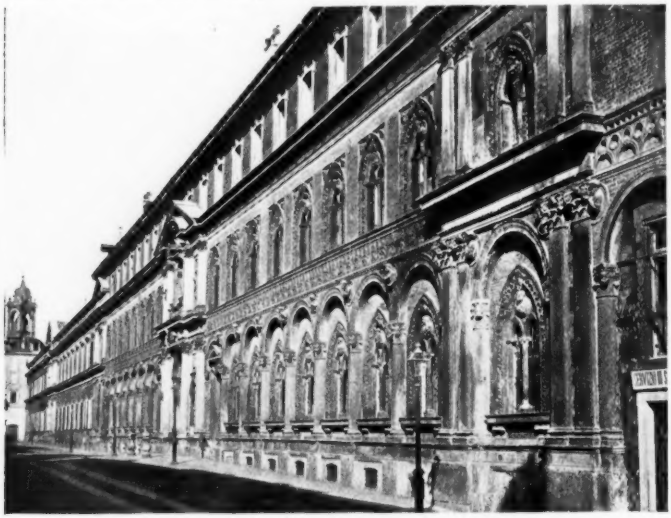
From the no-ventilation of the old hospitals where the air of the wards was so foul that even the well visitors were made sick by it, and the crude methods employed a few years ago, to the elaborate systems of fans for forcing in the air and fans for pulling it out; from the fitful drafts of wind to the flow of air automatically regulated; from the hot "chimneys" and stoves that were universal a few years ago to the steam and hot-water pipes that create an internal climate almost unvarying and quite artificial,—there is a distance as great as that between a log-cabin and a Queen Anne "villa." There have been volumes written on the subject of ventilation,—an operation whose rule can be summed up in less than a dozen words: drive out the foul, bring in the pure. One would think a mere child in invention could do that. But air, like other invisible elements, is not easily controlled: it can-

GREENWICH HOSPITAL, LONDON.



ST. THOMAS'S HOSPITAL, LONDON.

not be pulled, and it is most erratic when pushed. Consequently there are multitudes of people who are convinced that the chief advantage in the complex, expensive, and usually patented "systems" accrues to their manufacturers, and that the good old way of opening the windows when the wind blows and trusting to providence and the doctors when it does not is, after all, the safest and best. On the other hand, we are seriously advised to choose a "system" of heating and ventilating, have the plans for the same prepared, and then make the building fit the system. And yet the thing to be done seems so simple! Drive out the foul; bring in the clean. But at the very outset we strike one of the problems that have confounded the universe



FACADE OF OSPEDALE MAGGIORE, MILAN, ITALY.

from the beginning. If the good and the bad would only consent to be separated, it would be easy to strangle the one and cultivate the other. But nothing has yet been discovered that would eliminate and remove atmospheric impurities. It is a case of one out, all out; not even the family of Noah can be spared by the sweeping flood that purifies the ward.

Perhaps the most common popular fallacy regarding provision for ventilation is the notion that a sufficient outlet for air is the only thing necessary, which is much as if we should expect an open door for the escape of burglars to be an adequate protection against robbery. Bad air, like untrained boys, will go where it ought, if the way of duty

happens to be the easiest and pleasantest; otherwise, it will go where it ought not. For the necessary atmospheric washing, then, it appears that a certain amount of fresh air must be driven into the wards,—good authorities say 1 cu. ft. per second for each occupant,—and the same amount, of course, expelled. To secure at the same time sufficient warmth for the comfort of the patients, the incoming air must be warmed, or cooled, as the case may be, before it is brought in. Whether the chamber in which the air is warmed shall be placed under the ward, or at some distance from it; whether a single large chamber or several small ones shall be employed; whether the requisite amount of heat shall be secured by the direct combustion of the fuel, by steam,

COURTYARD OF OSPEDALE MAGGIORE, MILAN, ITALY.

by hot water, or by electricity,—are questions which will be answered according to varying conditions. The principle is the same, however it may be carried out; air artificially warmed, and compelled to go where it is wanted. Just where this shall be introduced is, I believe, still an open question. Air expelled from the lungs, which is by no means the least cause of atmospheric impurity, undoubtedly rises immediately after expulsion. Consequently the fresh air that is expected to wash out the impurities, if brought in above the heads of the occupants while the outlets are near the floor, must take this freshly-expired and unclean air and carry it down again. In the wards of the Johns

Hopkins hospital the inlets are near the level of the window sills, between 2 and 3 ft. from the floor, with outlets both at the floor and in the ceilings, the latter not being always open. In Massachusetts it is the practice in school rooms to admit the fresh air at a considerable height from the floor, the exhausts being at the floor. There is necessarily a loss of heat when warm fresh air is admitted at the bottom of the room and allowed to escape through the top with its double burden of dangerous impurities and precious warmth. I doubt if it has been demonstrated beyond question that a given amount of fuel will not secure as much purity and warmth in the atmosphere of a room with the so-called automatic ventilation as when the physical laws that regulate the movements of air and the diffusion of gases are opposed, which is the case when warm air is forced to come down, against its natural tendency to rise, and when it will perhaps form currents where an imperceptible flow is essential. The Spanish proverb that a scolding wife and a down draft are the two great evils of existence is generally accepted by civilized people the world over.

After the ward, its necessary adjuncts are to be considered. As Mr. Dick advised concerning David Copperfield, so the first thing to be done for a hospital patient is usually to wash him. This and other needs being constant, the bath-rooms, lavatories, and water-closets must be so near that the patients who can leave their beds at all can reach them with the least possible trouble. Then there is the "sun room," where they may be subject to that benign influence for which there is no artificial substitute,—the light and warmth of the sun's rays. Obviously, in the northern hemisphere this must look towards the south, and, as soon as a study of floor plans is made, it will appear that the best form for a single ward of twelve or more beds is, as a rule, an elongated parallelogram. It will also appear that the most convenient place for the sun room is at one end. Obviously this requires that the long axis of the ward shall be on the meridian line, which is well for other reasons. Even sick folks must eat, and the tea kitchen for supplying this need must be as near as possible. There are also various things necessary for their comfort and proper treatment,—medicines, bandages, bedding, towels, basins, and many other appliances and implements which must always be within easy reach. All of these things necessitate a group of small rooms and closets, which together constitute a "duty ward." This general arrangement for hospital wards was not reached until after the most careful study. Those nineteen thousand hospitals of medieval Europe never dreamed of such conveniences.

Perhaps the most careful and original study at any one time, the results of which have been most generally approved by farther study

and experience, has been that of Dr. John S. Billings and his associates, in the conception and execution of the plans for the Johns Hopkins hospital at Baltimore. A long room, wide enough for two rows of beds, each with its head near the outer walls and having a window at either side; sufficient floor area and height of walls to give each patient from 1200 to 1400 cu. ft. of space; every bed easily overlooked and approached by the nurse in charge; sunlight from morning till night; the essential offices and appliances as near to the ward as possible without obstructing light and air.

There are still other requirements, whether the hospital is large or small. For those who are suffering from accident or other causes demanding skilful surgery, there must be an operating theater, with its special arrangements and furnishings. There must be rooms for the nurses, not adjacent to the ward, but, on the contrary, remote from it. When on duty, their place is not beside the ward, but in it. There must be a roomwhere applicants for admission to the hospital can be received and examined, and rooms for the administrative officers, the superintendent, and perhaps the resident physician. All of these adjuncts and accessories may and ought to be separate from the ward, but the separation may be by distance or by barriers of masonry. The more numerous the patients, the more numerous and spacious will be the various administrative offices.

At the least, the administrative building, or department, should provide a reception and examination room; a room for the superintendent; a dining-room for the nurses and officers; an operating room; a kitchen and laundry; store-rooms for food and other supplies; a dispensary; and bed-rooms for as many nurses and servants as may be needed. The extent and arrangement of all these will depend primarily on the number of patients. Large hospitals may furnish suites of rooms for physicians, numerous consultation and examination rooms, medical library, and rooms for visitors and trustees and directors. There would be an operating amphitheater with seats for students, a home and a training school for nurses, a pathological laboratory, diet kitchen, accommodations for "out-patients," etc.

A large general hospital will have separate wards for diseases requiring special treatment. Each of the numerous contagious diseases may have its own ward, and the list seems to be constantly extending. With the evolution of the "germ theory" the value of isolation becomes more and more apparent.

It would be impracticable in a single article to give detailed description of the various equipments of the duty ward: the linen closets; the fittings for the patients' clothes-rooms; the drying-closet; the stool-closet; the disinfecting chambers for bedding and clothing;

the lifts for food, supplies, fuel, and implements. In all these there must be the same regard for durability, the same provision against dirt, decay, and combustion.

The floors of the duty ward, of the corridors, and, in fact, of nearly all the administrative offices, except the bed-rooms, should be of the most durable cement or tiles. Perhaps nothing is better than a pavement of "mischiati,"—small blocks of marble bedded in cement. The walls and ceiling of the operating theater may be lined with marble or large sheets of glass, which will allow the most thorough, frequent, and forcible cleaning. As a matter of fact the floor is the critical point, but for convenience in cleaning the floor the walls may also be unassailable.

Speaking in a general way, as regards plan and construction the contagious wards should be treated like the common wards. For special wards—ophthalmic, paralytic, maternity, and others—modifications of the plan are necessary. Children's wards, among other things, should have special regard to the cheerfulness of the outlook and the concealment, as far as possible, of the inevitably depressing accompaniments of sickness. It is hardly necessary to suggest that the operating theater should have ample ceiling as well as side light, and that an etherizing, a recovery, and a surgeon's room belong to this family. The mortuary and post-mortem building will naturally be detached from all others. The kitchen, laundry, and heating arrangements, including the storage of fuel and any machinery, constitute another family, and should be in close proximity to each other, if not in a building by themselves. The general service should be completely separated from the strictly hospital work.

No reference has been made to the "pay" wards, which are essential to every complete hospital. In fact, to these the steady improvement in hospitals may be attributed.

The training-school for nurses, which could hardly exist without the hospital, promises to effect a universal reform in the care of the sick, wherever they may be. Beyond the influences which those "ministering angels" exert upon the patients in their immediate charge, they become incidental, but none the less effectual, instructors in the private homes where they are professionally employed.

In all respects these beneficent institutions are in harmony with the spirit of the age. I wish there were more space for a plea for their visible beauty, but it is always true that the architectural road to the Palace Beautiful is through the iron gate of Utility; that the noblest architecture is the simple, direct, and faithful expression of a well-understood and beneficent purpose.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES, GREAT BRITAIN AND THE BRITISH COLONIES.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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ARCHITECTURE & BUILDING

The Practical and Impractical in Architecture.

IN "Architectural Education for America," by Barr Ferree, in No. 6, Vol. III, of *The Architectural Review*, the author partly coincides with the view that a knowledge of all the multitudinous things that enter into architectural practice is not needed to insure good design. At the same time he does not use the word practical as indicating such an intimate knowledge of common details,—for example, "the relative value of variously insulated wires," etc.,—and goes on to state what he considers practical and impractical in architecture.

"The practical in architecture means a full understanding of the actual conditions under which modern buildings are erected. An architect fails to meet the requirements of practicability in architecture today when, for example, being called upon to design a monumental memorial, he presents a gigantic scheme, with subsidiary buildings, terraces, colonnades, extensive gardens, and a multitude of minutiæ, very charming to look at, no doubt, but conceived on too grand a scale to meet the practical and reasonable requirements of cost, even assuming the design were artistically beautiful, which is quite another thing. An architect is unpractical when, being able to think in one style only, he tries to apply it to every problem under the sun,—as when he seeks to design a twenty-story office building in the Renaissance, which is essentially a broad and low style. He is unpractical again when he designs a humble country house at moderate cost in a 'monumental' manner. He is unpractical when he submits to a client a design calling for the expenditure of 20, 30, 50, or even 100 per cent. more than he has asked for. He is unpractical when he insists on style instead of on common-sense solutions of ordinary problems. He is unpractical when he overloads his designs with ornament, when he intrudes his own personality upon it, when he does not consider atmospheric conditions or location of site, when he does not carefully distinguish the use of materials in diverse localities, when he introduces vagaries into his work, when he designs in the clouds or in the fifteenth or sixteenth centuries, instead of on the earth in the nineteenth,—in fine, whenever, architecturally, he does those things he ought not to do. He may not himself need to be an expert on wires, but he must know that the man he employs to attend to that detail for him will do what is best; not a blind trust in another, but actual personal knowledge of the other's ability to judge and serve him. I should not like to set a limit to the practical knowledge he should have of materials and of construction, of health and life, of the requirements necessitated by the uses to which his building is to be put."

Mr. Ferree's article is in the nature of a critique upon an article by Mr. Albert L. Brockway, printed in a previous number of *The Architectural Review*. He corrects the statement made by Mr. Brockway that four articles, written respectively by Arthur Rotch, Robert D. Andrews, R. W. Gibbon, and Mr. Ferree, contributed to Vol. VII of *The Engineering Magazine*, "were published with the view of demonstrating that architectural education in America should be different from that of any or all other civilized countries." The articles were published with no such end in view. "The gentlemen who wrote them were each asked to present the special claims and advantages of the system under which he had been trained; the articles were not printed in the interest of any one system, but simply that the distinctive characteristics of the chief systems by which the architects of to-day are trained might be brought together in a connected discussion. If, however, the effect of these articles, brought together for no other purpose than this, was to show that a different

system of architectural education is needed in America from that which obtains in other lands, then they have produced a result that lies very near to my heart, for in such differentiation, specialization, and Americanization of our architectural education lies, I am very sure, the regeneration and salvation of our architecture."

The charge is made by Mr. Ferree that the training in the School of Fine Arts at Paris is essentially a paper training. "The problems presented to the students from year to year are, very much, as a matter of course, identical problems. And, in preparing his work, the student does not seek inspiration or suggestion from actual buildings, but from the previous paper designs of previous students. An artificial atmosphere of unreality and drawing-paper is thus created that it is the hardest thing in the world to escape from. And, when these gentlemen go forth into the world to produce actual buildings, they are hampered by the unreality of their training. The errors and misfortunes of most French buildings arise from the fact that the actual work is not carried out under the same untrammeled conditions that obtain in the school. The magnificent designs prepared for the Grand Prix, and which every student in the school views with bated breath and in awe-stricken attitudes, are simply exercises on drawing-paper that no one ever expects to build. In his very early days the present writer found vast amusement in manufacturing designs by spreading out colored cards on the floor; and very marvelous and stupendous designs they were, 'though I say it as shouldn't.' I fail to see any difference between that childish amusement and the exercise solemnly performed by grown men in the School of Fine Arts at Paris. It is paper from beginning to end; only in the Paris case there is distinction to be gained among one's fellow-students, and, in the end, perhaps a diploma from the government of the French republic. The paper results are, as a rule, more satisfactory than those in brick and stone. Are we, then, to have a paper architecture in America?

"We need an architectural education for American architects that will serve American needs and answer American conditions. The Beaux-Arts men get so far up in the clouds with their paper designs that they often find it difficult to come down to the hard realities under which architecture is carried on in this country. More than this, they are hampered by feeling for a style, or for styles that do not readily lend themselves to the many varied structures called for in American life. Be their principles what they may, they are, with few exceptions, stylists who think and work in one style all the time, entirely oblivious of the fact that they cannot do with a style something that, in the very nature of the problem, is wholly foreign to it."

The New City Hall, Jersey City, N. J.

THE ARCHITECTURAL RECORD (July-September) makes the design of this building the subject of a caustic, specific criticism, and speaks generally of suburban public architecture as being "always particularly vile." The truth of this proposition must be conceded. The suburban districts of a city ought to be one of its most attractive features, but almost invariably, when a school, a police station, a concert hall, or a library is erected in one of these districts, it becomes a more or less permanent disfigurement. Just why or how this comes about the article under review does not explain. Most people will refer it to political rottenness in municipal affairs.

The contrast between public and private architecture in suburban districts is particularly noticeable. One passes through a group of beautiful villas and cottages to a space whereon stands a handsome church (nowhere else does church architecture look so beautiful as among the graces of trees and shrubs and vines), and just opposite may stand a hideous structure that might be anything,—barn, factory, or lager-beer hall,—for all that its exterior reveals, its ugliness being in startling contrast with the beauty of its surroundings. For this there is not the slightest excuse, though there is a cause.

"Unluckily the projectors of suburban public buildings imitate the urban public buildings. To have an artistic suburban public building would require, first, a willingness to have the status of their municipality as a suburb expressed, and, secondly, discernment enough to choose an architect capable of expressing it. The first of these conditions is very apt to fail in all American municipal architecture, and this for the obvious reason that the inhabitants of an American town of the second or the third or the fourth class are apt not to acquiesce in the existing status of their town, but to lay out their public buildings on the scale of the town that they hope it will be when the 'boom' has been fulfilled,—to lay out their public buildings as part of the boom. Hence, even when they have the luck to fall in with a good architect, and when the design shows sensibility and scholarship, it is apt to be more 'cityfied' and pretentious than the facts warrant, and this pretentiousness is with difficulty distinguishable from vulgarity. When the municipality is a suburb, the suburbans are apt to project their works on a metropolitan scale. Thus one of the conditions precedent to an artistic and appropriate public building has failed. When the other fails also, and an incompetent designer undertakes to simulate a public building more solid and costly than his client can afford with an array of cheap finery, the resulting edifice fairly reeks of vulgarity, as reeks the new city hall of Jersey City."

The anonymous writer of this article makes his sarcasm of richer flavor by a vein of humor that runs through it all. "The illiterate and incompetent practitioner so strongly resembles himself, wherever found, that to have seen one of his works is to have seen them all. By a curious revenge of fate upon him, 'variety' is the thing he always aims at and never attains, and the more he struggles for variety and novelty, the more monotonous and trite he becomes. His method is always the same. He desires to get as many 'features' as possible in a given front; he desires to make each of his fronts as different as possible from the adjoining front. A piece of plain wall is his chief aversion. It seems to him that, if he does not 'do something' with it, he is not earning his money or vindicating his capacity. Lord Melbourne's famous question, 'Can't you let it alone?' never by any chance propounds itself to him. To give a front a countenance it is necessary to him to furnish it with a minimum of two noses and four ears. If he cannot put on more things for the money in cut stone, he cheerfully adds them in sheet metal. At all hazards he must have plenty of things, and his variety thus comes to mean nothing but thinginess.

"His procedure is illustrated with an amusing *naïveté* in the work now under consideration. His principal front has things enough for a front three times as long. At the centre, to begin with, there is a porch with two columns on each side, with composite capitals, inclosing a Romanesque entrance arch with two nook-shafts on each side. One is amused to remark here, as elsewhere throughout the building, that the carving is done 'in place,' as if the sensitive soul of the designer could not be appeased without seeing its actual effect in execution,—an assumption which becomes wildly hilarious when applied to forms that are transferred bodily from the 'Stair Builders' Guide.'"

Omitting further criticisms of details, our purpose in this review being merely to show the emphasis laid upon the generally unsatisfactory character of suburban public architecture, we quote further the concluding paragraph only.

"If one encountered this disreputable structure in Oshkosh, he would say, how Oshkoshian!; in Peoria, how Peorian!—it is so rude and raw a travesty of the architecture of civilization. As a matter of fact, it is in one of the oldest settlements of the United States, and within a mile or less of it is a respectable dwelling erected in 1666. This is not the brutality of a blundering beginning, but the hopelessness of a completed degeneration. The building which expresses the municipal aspirations and standards of Jersey City, would be a standing disgrace to a municipality of South Dakota by its crudity and vulgarity.

The Age of Brick.

UNDER this title *The Canadian Architect and Builder* prints an article which presents the claims of brick to be regarded as the best building material known to architecture. While many of the finest buildings of the early Christian period have fallen into utter decay, the most perfect buildings that have survived from ancient periods are of brick. Many of those composed partly of brick and partly of stone are in a fair state of preservation, and "not a single one of the great buildings composed of bricks altogether is known to have disappeared."

"In fact, the most perfect buildings that have come down to us from the earliest days are built of bricks, and we have evidence in a thousand and one instances of the superior lasting properties of bricks over all other known building materials. The Pantheon, the building of which dates back more than a century beyond our era, is built of bricks backed up with concrete, and, despite the bandit and barbarism, and the tooth of time, it still remains almost entire, as an object lesson in the use of bricks. The great Gothic Church of San Stefano, Venice, though badly designed and worse constructed, shows the bricks of which it is built to be as sound and shapely as when first laid, though held together by a very inferior mortar.

"The Triumphal Arch erected at Rimini in honor of Augustus is partly constructed of bricks, and partly of marble; but, while the marble is nearly rotten and dropping to pieces, the despised bricks remain perfect, and hold together the whole structure and its decaying aristocratic veneering.

"By far the oldest pyramid is of brick,—the one of Sakhara, said to have been erected more than a thousand years before Jacob wandered into Egypt. It still holds together, and gives promise of being a thing of mystery for a few thousands of years more. Indeed, we believe the Pyramid of Sakhara is supposed to be the oldest structure known. The temple of Thebes and the great Pyramids of Gizeh are modern by comparison."

Material for the manufacture of bricks is abundant and widely distributed in easily accessible places. The manufacture of plain bricks is easy. It is a better non-conductor of heat than stone; it resists climatic influences better; it withstands the action of intense heat; and, when well made, its strength compares well with that of stone. "It can be carved, if necessary, with considerable definiteness, and it costs less than stone." Recent advances in brick manufacture are great. "In olden times the architect was obliged to have all his moulded and ornamental bricks made by inexperienced workmen, under his own supervision. In the construction of a large building of brick the brick-maker was one of the architect's staff, and made his bricks to the order of his superior. His appliances for making and burning were of the crudest sort, and, as we know from examination, old bricks were often badly burned. To-day the architect may choose his bricks from catalogues, making his own choice of shape, quality, and color, and can rely on getting what he orders; and he can order to suit his design, whereas the old builders were obliged in almost every case to make their designs to suit the materials available."

The Durant System of Hollow Terra Cotta Construction.

ALTHOUGH during the last quarter of this century much use has been made of hollowed blocks of baked clay in buildings, *Brick* for June says that the possibilities of utility and beauty wrapped up in them have been hidden. It presents a color-plate of a Romanesque residence which, excepting the foundation, is built wholly of hollow terra cotta building blocks, adducing this as proof of the beauty of the material, and of its capabilities for producing structures of the highest order of artistic merit. Certainly the structure looks exceedingly well on paper. Interesting sketches of details of this building are shown, which illustrate possibilities of the system under consideration.

The basement is built of rock faced blocks, imitating very exactly coursed-dressed ashlar; and the upper walls are a

good imitation of broken ashlar work. The tables, belt courses, window-sills, and casings are all artistic. It is explained that this transformation from the coarse and "unpresentable hollow block of the past is all accomplished by affixing to the discharge ends of the die of an ordinary auger brick- or tile-machine a roller die which is operated by the moving mass of clay.

"A clay that can be vitrified without too hard a burn to change its color is desired; a plastic or bastard fire-clay is found very satisfactory, and shale clays with proper plasticity are equally desirable. Good clays are always found in abundance wherever coal is found, and in many other localities. The clays named are preferred as not absorbing moisture, and hence are free from discoloration from efflorescence, etc., and are also unaffected by freezing and thawing. They can be glazed or otherwise, as preferred, with no addition to their cost for glazing. For foundations, glazing is considered very desirable, and many prefer glazed casings, trimmings, etc., as it gives variety and brightness. These blocks weigh about four-tenths as much as brick of the same cubic space, and hence will widely extend the area of the manufacturers' market. Eastern Ohio manufacturers ship to Boston and Chicago."

To ornament the blocks is easy, but this is not alone sufficient; "they must have a good mortar joint to stand the weather to make them first-class, and must comprise a good door and window casing that can lock into the wall and hold securely the frame as against any contingency. But there is much more connected with ornamentation; as the introduction of color to bring out boldly the design imprinted, and also to color tuck-pointed joints, as in the case of the broken ashlar blocks, all being done by the one process at the mouth of the die and the colors burned in. Then the blocks must be perforated for piping, wiring, ventilating, etc., the perforating being simultaneous with the ornamentation and at both the top and bottom of the block." The machinery is said to be well planned for these last improvements, but is not yet on the market. The perforation improves the blocks; they burn more evenly, fuel is saved, and in a day's run 3 to 4½ tons of clay are saved, with the consequent saving in freights. It is said further that this system of building admits of improved heating and ventilation, and that the strength of the foundation blocks is such that, with the furniture in the building, only ¾ per cent. of the total crushing pressure is put upon the lowest tier of the foundation blocks.

Bronze Doors.

THE AMERICAN ARCHITECT (July 13), in an answer to newspaper criticisms upon the sculpture and other decorations of the Boston Public Library, incidently questions the wisdom and propriety of decorating bronze doors in such frequented buildings. On this point it says: "The labor and skill consumed in producing bronze doors is in large measure waste effort, since to be appreciated bronze doors need to be closed, and a library with closed doors is hardly a profitable institution. As the doorways are hardly wide enough to allow the construction of a *guichet* in one valve of each door, these bronze doors of French's must, save on holidays, stand open, and his work must be seen imperfectly by the aid of internal or reflected light without the aid and accent of direct cast shadows. Moreover, people who wish to examine his work at their leisure can only do so under penalty of becoming nuisances through forming obstructions to free and unobstructed passage through the doorways; and the chief use of doorways is to afford such passage, and not to constitute an art gallery."

An answer is also made to the prudish objections raised in some quarters against the nude bacchante by MacMonnies presented to the library by Mr. McKim, and which will adorn and grace the courtyard. In this case, it is thought, a concession ought to have been made to the objectors, or the class represented by them. "The vigor of the attack by those of prudish inclinations and the citations they made from classic authorities was only equalled by the quickness with which the defenders discovered other citations, and upheld the modesty and virtue of the priestesses of

Bacchus. In this case, as in that of the *putti* on the front of the building, we, while not sharing in any way the prejudice against the nude in art, feel that, since there are very many respectable people who prefer that their art works should present the skill of the human tailor rather than that of the Creator, it is a mistake in the case of a public building to please one portion of the public at the expense of another. From one point of view we are very glad that the 'Bacchante' is to find a place at the library, since it will show that MacMonnies is capable of doing better work than is represented by the sketchy and theatrical figure of Sir Harry Vane, which at present stands somewhat disconsolately in an upper room of the special library floor, and is apparently wondering why any one ever thought of placing his bulk indoors."

Protecting Roofs from Fire.

THE IRON AGE prints a circular prepared by a Boston fire insurance company and calling attention to a danger which, the company says, has been disclosed in the four principal losses to which it has been subjected in machine and metal works,—to wit, the risk of wide areas of wooden surface in the roofs of foundries, steel works, and the like. It is explained that "the danger does not consist in any great liability of fire originating in these roofs or upon the extensive surfaces of wood. The four fires which have caused heavy losses have all originated in some other part of the works, from which they have extended to the roofs or other extensive wooden surfaces and have there exerted their destructive influence."

The circular invites suggestions to aid the company in providing against the special hazard named. We venture to offer such a suggestion. Raise the rate to a figure which will inhibit owners from using such roofs. Wooden roofs are not a necessity for the class of dwellings named. A caution is made against the use of varnish, though the connection between their use and foundry roofs, etc., is not very apparent. We do not remember to have seen such roofs varnished. "A good coat of whitewash or kalsomine serves to retard the rapid spread of fire, but varnishes, or other finish in which oil, resin, turpentine, and sometimes benzine are used, should be absolutely refused admission into any building which it is intended to protect from loss by fire." But better than kalsomine, better than anything else as a preventive, is an advance in rates, or, in case of mutual coöperative insurance associations, a total refusal to admit such risks.

THE fall of the building at West Broadway and West Third Street, New York, on August 8, by which fifteen lives were lost, seems to be another one of those conspicuous examples of distributed neglect for which the annals of building in New York have become famous. Architect, contractors, the building department, each and all seem to have neglected their duties, the result being a catastrophe much too common in these days of skin building.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*10. The Architecture of Modern Hospitals. Ill. E. C. Gardner. (Their interior design and location.) Eng Mag–Sept. 4500 w.

59. Architectural Education for America. Barr Ferree (A critique on an article by Mr. Albert L. Brockway; a discussion of the practical in architecture, and a plea for an architectural education for American architects that will serve American needs and answer American conditions). Arch Rev–Vol. III. No. VI. 5000 w.

84. Steel Framework for Minneapolis, Minn., Court House Roof. Ill. (Problems in design; system of trusses). Eng News–July 11. 1100 w.

†128. Ancient Methods of Spanning Openings and Spaces. J. B. (Ancient practice in India; ingenious use of stone beams). Ind Engng–June 8. 1900 w.

184. English Country Churches. Ill. A. B. Bibb (An architectural study of rural English ecclesiastical architecture from the art standpoint). Am Arch–July 13. 1700 w.

185. Delphi (The French excavations from the engineer's plan). Am Arch–July 13. 5000 w.

186. Boston Public Library (Editorial reply to newspaper criticisms). Am Arch–July 13. 600 w.

We supply copies of these articles. See introductory.

*191. John Sell Cotman and Architecture (His work with specimen illustrations. His place among landscapists and architectural draftsmen). Arch, Lond-July 5. 1400 w.

*192. Architectural Antiquities of Normandy. Arch, Lond-July 5. Serial. 1st part. 1500 w.

*193. Abbey Church of St. Stephen, Caen (Historical and descriptive). Arch, Lond-July 5. Serial. 1st part. 4800 w.

*214. The Representation of Architecture at the Royal Academy (Criticisms—editorial, and extracts from letters to the editor; much dissatisfaction expressed). Builder, Lond-July 6. 5400 w.

*215. A New Roman Catholic Cathedral at Westminster (Descriptive). Builder, Lond-July 6. 1200 w.

*216. Metals Used in Building. Serial (Will describe the ores from which the metals are obtained, alloys and mixtures of metals, casting, moulding, etc., of metals for architectural work in England). Builder, Lond-July 6. 1st part. 1300 w.

264. Protecting Roofs from Fire (States a special hazard in wide areas of wooden roofs, in foundries, steel works, paper works, &c. and invites suggestions for prevention). Ir Age-July 18. 1500 w.

300. Masons and Builders' Schools in Germany (From a recent consular report. Gives the most recent practical and theoretical knowledge obtainable). Arch & Build-July 20. 1500 w.

301. Sound in its Relation to Buildings. H. W. Burrows (Review of late opinions). Arch & Build-July 20. Serial. 1st part. 3000 w.

*306. Architecture in London. Ill. Barr Ferree (Characteristics; materials; sloping roofs; modern buildings, etc). Arch Rec-July-Sept. 9500 w.

*307. A French Dining-Room of the Upper Middle-Class Type. Ill. Fernand Mazade. Arch Rec-July-Sept. 4000 w.

*308. The Royal Polytechnikum at Berlin and Student Life in Germany. Ill. Albert F. M. Lange (College for the study of architecture, engineering, mining and chemistry). Arch Rec-July-Sept. Serial. 1st part. 3000 w.

*309. Architectural Aberrations. The New City Hall, Jersey City, N. J. Ill. Arch Rec-July-Sept. 1500 w.

*310. The Education of an Architect. Henry Rutgers Marshall (Some of the general principles which should guide us in giving this education). Arch Rec-July-Sept. 7000 w.

*318. The Age of Brick. F. T. H. (Attempt to prove it durable and the best and most natural building material). Can Arch & Build-July. 900 w.

325. Switzerland's Building-Material Station (For the testing of building material. A branch attached to the Federal Polytechnic School at Zurich). Eugene Germain. Am Arch-July 20. 900 w.

*326. Architectural Antiquities of Normandy. Abbey of the Holy Trinity of Caen. Ill. Arch, Lond-July 12. Serial. 1st part. 2500 w.

329.—$1.50. "Frauds and Abuses at St. Paul's," 1712 (An attack by one Dr. Hare upon Sir Christopher Wren, and the latter's reply. An interesting historical note). Jour Roy Inst of Brit Arch-July. 700 w.

330.—$1.50. Tour of the Pugin Students 1894. Ill. (An interesting description of an English tour with sketches of architecture in many towns). Jour Roy Inst of Brit Arch-July. 3000 w.

331.—$1 50. Philadelphia: An Architect's Notes in an American City. H. Bloomfield Bare (How an English architect regards the Quaker City architecture). Jour Roy Inst of Brit Arch-July. 5000 w.

332.—$1.50. Theoretical and Practical Notes on Beams, Columns, and Roof Trusses. J. M. Moncrieff (A very important, exhaustive and instructive paper. The experiments with brick cantilevers will be interesting to many readers). Jour of Roy Inst of Brit Arch-July. 9000 w.

333.—$1.50. Art in Primitive Greece as Treated by Georges Perrot and Charles Chipiez. Ill. Francis C. Penrose (A critical review of the history of Art in Primitive Greece by the authors named). Jour Roy Inst of Brit Arch-July. 2500 w.

*343. Brownstone in New York City. R. S. Taite (Unjust prejudice). Stone-July. 1300 w.

†396. Some Characteristics of Pre-Conquest Architecture. Gerald Baldwin Brown. In Arch-July. Serial. 1st part. 6400 w.

*429. Colored Brick. R. C. S. (The danger of color in the hands of the inexperienced. Workmanship of more importance than material). Br Build-July. 1100 w.

*430. Terra-Cotta Fragments. Ill. Fritz Wagner. By permission of Clay-Worker (In proof that terra-cotta can be used constructively for classic cornices). Br Build-July. 900 w.

438. The Railroad Shops at Wabash, Ind. Ill. (Plan, details, trusses, columns, girders). Ry Rev-July 27. 700 w.

*466. The Building Laws of Byzantium (Emperor Zeno's building law the admiration of Roman jurists). Arch, Lond-July 19. 2500 w.

*467. The Sanitary Aspects of the London Building Act, 1894 (A paper by G. Blundell Longstaff read at a meeting of the Sanitary Inst). Arch, Lond-July 19. 4300 w.

590. Berlin Tenement-Houses (Report of Consul-General Charles DeKay in response to interrogatories sent out by Committee). Am Arch-Aug. 3. 3000 w.

591. A Syllabus of Early Christian, Romanesque and Gothic Architecture. M. Wergeland. Am Arch-Aug. 3. Serial. 1st part. 2700 w.

592. Mural Decoration in Situ. Frederic Crowninshield (In favor). Am Arch-Aug. 3. 700 w.

648. Portland Cement Concrete for Architectural Decorations. Ill. (A plea for a better appreciation of the possibilities of concrete in decorated architecture.) Eng News-Aug. 8. 800 w.

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Adulterated Portland Cement and Blast Furnace Slag.

THE *Engineering and Mining Journal* of July 6 contains an article by A. D. Elbers, entitled "Adulterated Portland Cement and Blast Furnace Slag," that is of especial interest to all engineers. After explaining the origin of what is now termed Portland cement,—*viz.*, that it was an English invention made in imitation of an earlier English cement called Roman cement, made by burning an argillaceous limestone or calcareous clay into a cement and named "Portland" because of the similarity of its color to that of the famous Portland building stone,—he goes on to the definition of this product, which is as follows: "A material made from natural or artificial mixtures, consisting of clay and carbonate of lime, that contain the essential ingredients of these substances in certain relative proportions, and that have been subjected to an intense heat until all of the lime has become chemically combined with the other ingredients."

What the resulting compounds represent—whether they are compound silicates of alumina and lime or a mixture of aluminates and silicates of lime, etc.—he does not undertake to decide, but inclines to the opinion that the mixture must be such that, if completely fused, its basicity would be such that the alumina would play the *rôle* of an acid. He does not believe that in the manufacture of Portland cement such a reaction takes place, or that it can take place, because at the temperature of manufacture "the burning happens to be regulated in such a manner that the hard frittering or sintering masses of clay and lime begin to cool off when the silicate of alumina is just on the verge of splitting up into silica and alumina, which tendency is materially assisted by the presence of ferric oxid, or even of calcium ferrate."

He cites several facts of observation to substantiate his view of the correctness of his theory, the first of which is this: "In cooling, overburned cement either crumbles or falls to powder, just like slacking blast furnace cinder, whereas well-burned cement stock remains so solid that it has to be broken out of the furnace with crowbars. But the specific gravity of well-burned as well as of underburned cement is greater than that of overburned stock of the same composition, which shows that the overburned must have undergone an additional chemical change, and that change is apt to consist in the more copious formation of aluminates. Both overburned cement and slacking blast furnace sinder set in water, but the hardening of the set masses does not amount to much. It is therefore to be assumed that the most of the alumina of the normal cement is still in the condition of a silicate constituent, and that the setting capacity of the normal cement is chiefly due to its large contents of silicates, that are so basic that they change readily to hydrosilicates when mixed with water, the latter playing in this case the *rôle* of an acid" (*sic*).

He thinks that this silicifying process (upon which the hardening depends) may be intensified in Portland cements by mixing it with silicates "that yield a great deal more of gelatinous silica than is set free by the decomposition of its own silicates," —whatever that may mean.

The failure of the many attempts to make a saleable cement from blast furnace slag and lime he attributes to the erroneous idea that, in burning such compositions, the lime of the slag would have the same effect as an equivalent amount of admixed free lime, and that, consequently, only a small proportion of the latter would have to be added to the slag, "whereas the strength of cement depends on the very condition that the silicate of alumina has been reacted upon by free lime."

He regards the lime of the slag, so far as its useful effect for this purpose is concerned, as useless.

He thinks that the composition of the

Portland cement *before it is burned* is not likely to be adulterated, because the resulting product would be so inferior to that from the ordinary raw material that there would be no inducement.

"On the other hand," he says, "adulterations of the burned stock, made either before or after it is ground, may escape detection." Some so-called adulterations —*viz.*, the addition of puzzolane, etc.—he thinks may be of actual benefit, since "the genuine Portland is rather deficient in the proportion of its soluble silica as compared with that of the lime that dissolves with the silica." He says: "It is, therefore, an open question whether the ultimate hardness of pure and finely-pulverized Portland could not be considerably increased by such admixtures" (Mass Santorin earth and puzzolane).

Now, while blast furnace sinder of the singulo-silicate type would seem to offer a good substitute for these admixtures, and should theoretically fill the bill, he points out that the singulo-silicate slags contain impurities that are not permissible,—the first of these is sulphur, which is most antagonistic,—and, if free from sulphur because very acid would defeat the very object for which it was added.

"As to the utilization of blast furnace cinder for cementing purposes," he says, "it is not likely that it will ever amount to much until sulphurous slag is desulphurized by some cheap method. But, whenever that is accomplished, then the genuine Portland cements, as well as the hydraulic mortars that are made from volcanic earth, will meet with serious competition."

This calls to mind a natural cement, somewhat resembling puzzolane, which is found over very extended areas of Mexico, but is apparently unknown in this country. It is a superficial deposit, evidently the result of the decomposition of the volcanic rocks, and in its purer state almost perfectly white. It is prepared for use by burning and then quenching with water in order to bring it into a pulverulent state. It is then mixed with one-third or two-thirds the quantity of sand or loam and sufficient water. It is an exceedingly tenacious cement, has excellent hydraulic qualities when properly mixed, and is used almost exclusively in some portions of Mexico. It is largely due to this cement that the older stone structures in that country remain in their remarkable state of preservation, and it is exceedingly strange that an article of such merit, so near our doors, has gone unnoticed.

The Effects of Low Temperature on Iron and Steel.

THE *Engineering Record* of July 13 discusses editorially the effects of low temperature on iron and steel. It calls attention to the fact that, although experiments were instituted as far back as 30 to 40 years ago to determine this question by the best authorities and have been continued up to the present time, it is still an unsettled question. The investigations of Sandberg and Styffe, and the results of the extended observations made on steel rails in use in all seasons of the year in Russia, as well as the more recent experimental work of Mr. Thomas Andrews, F. R. S., all go to show the unreliability of present data, because of their contradictory testimony. It says: "As a matter of fact, it is not incautious to state that not even such an intimation (as to the law which governs the variation of strength of iron and steel with temperature) can yet be discovered in all the results of this experimental work, at the very beginning of which Styffe and Sandberg arrived at diametrically opposite conclusions, the latter maintaining that the capacity of resistance to impact of iron rails, as well as their ductility and flexibility, was very seriously impaired at a temperature of 10° F., while Styffe confidently concluded that neither the ultimate resistance nor the ductility of either iron or steel was sensibly affected 'at the lowest temperature which ever occurs in Sweden.'"

"It has sometimes appeared that steel rails are somewhat more liable to break under traffic in winter than in summer, but, on the other hand, the statistics drawn from railway experience in such cold climates as those of Russia and the State of Massachusetts usually substantiate a conclusion of an opposite character. The

later experiments of Mr. Andrews were made upon car-axles, which were submitted to impact up to failure at low and high temperatures obtained by freezing mixtures and hot water respectively. These investigations were continued throughout a period of several years, and seemed to indicate that the resilience, or capacity to resist impact, of the iron used in the axles was considerably less, perhaps even one-third or one-half, at the low temperatures than at the high. The results of these experiments, it is thus seen, at first sight contravene the conclusions which may be based apparently upon perhaps the greater portion of the earlier experience and experimental work."

It goes on to say, however, that it is not only possible, but highly probable, that one or two elements have not been considered.

"Wrought iron, which contains from $\frac{1}{10}$ to $\frac{25}{100}$ per cent. phosphorus, has too much of that prejudicial element for many purposes, and there is much evidence which cannot be ignored, pointing to the conclusion that such metal may be seriously affected by a low temperature which would have little or no effect upon wrought iron containing sensibly less phosphorus. In fact, it is undoubtedly true that the presence of that element affects very seriously the capacity of either iron or steel to resist impact, nor do we believe that any safe conclusions can be based upon experimental work in this field without giving a careful quantitative recognition, so to speak, to the chemical constitution of the metal tested."

It accounts for the contradictory testimony on this ground, therefore,—which is certainly well taken,—that physical tests of any kind are of little value, unless the chemical constitution of the material tested is accurately known. Phosphorus is but one, although an important, element that controls or has an influence upon the physical qualities of iron and steel. It is becoming of less importance because of the improved methods of manufacture which render its presence less conspicuous to-day, even in metal produced from high phosphorus ores, than it formerly was in that produced from the better grades. Modern investigation has shown such a controlling influence of other impurities in minute proportions as was not suspected before, and this, in the absence of information as to the exact composition of the material tested, renders, as the *Engineering Record* maintains, previous data of little value.

The editorial concludes with the following statement. "There is, again, another aspect of this question which has never yet been investigated, and that is the elastic endurance of iron or steel at low temperatures, even though it contains a relatively high percentage of phosphorus. There is an enormous amount of metallic structural work in which no member is ever supposed to be stressed anywhere near its elastic limit, and it is a matter of great practical importance to determine whether the endurance of metal under such conditions can ever be affected by low temperature. Indeed, this whole question is one of many phases, and we are strongly of the opinion that safe conclusions will never be reached until the full effects of those influences which we have pointed out are recognized, and, when they are recognized, we believe it will be found that phosphorus is one of the most active elements in the impairment of ultimate resistance and ductility, at low temperatures."

Stream Measurements.

AT a meeting of the Engineers' Club of Philadelphia Mr. F. H. Newell presented an interesting paper on the methods and results of stream measurements by the United States Geological Survey; and the paper is given, with illustrations of current meters and charts of some typical observations, in the *Proceedings* of the club for July. After reference to the importance of hydrographic work as a basis for irrigation, power, or municipal water-supply engineering enterprises, the author explains that, in the selection of river stations for observations, it is of course impracticable to measure all or most streams, but that, if one or more important rivers in each State can be measured, the results possibly can be applied to other streams

coming from catchment basins of similar altitude and under like climatic conditions. The points selected in each of the larger drainage basins were usually near railroads, and, wherever practicable, river gages were attached to railroad bridges, records being kept by employees of the roads. As it is impossible to make direct measurements of the quantity of water flowing day by day in many streams without great expense, the less direct method of height gaging has been resorted to. For this two classes of observers are required: the one to keep regular readings of the height of water at short intervals throughout the year; the other to make measurements of quantity, such that the relation of height of water to discharge may be known. This relation is not exactly fixed, varying somewhat according as a river is rising, falling, or stationary, and is also modified by the direction of the wind. But, by comparing meter and gage measurements and plotting the results on cross-section paper, a mean rating curve is obtained which answers in ordinary cases. From the curve thus obtained, values are taken for each tenth-of-foot gage reading, constituting a table from which the discharge corresponding to any given height can be had.

For keeping record of height of water many automatic instruments have been devised, some of great ingenuity; but the author says that for the purpose of the work of the geological survey it has been found, after many trials, that better results can be obtained by the simple method of having a man residing near the spot note down once, twice, or three times a day the height of water upon a suitable device, or measure it directly. Mr. Newell reports that the recording nilometers, or tide gages, give excellent results when carefully installed and when they can be watched by skilled men, but that almost without exception they fail when placed in charge of the ordinary unskilled man. If several hundred dollars were spent in a thorough equipment at each station, and in such protection that an instrument could be left safe from meddling, it would be possible to obtain very accurate continuous records, but economy forbids the use of this method on an extensive scale. The river gages are usually vertical rods marked in feet and tenths. Occasionally inclined rods, following the slope of the bank, are used, these being marked to equivalent vertical feet and tenths. In a few cases the height of water is ascertained by a weight lowered by wire from a bridge.

Floats are occasionally used for measuring quantities of water, but for convenience and economy of time some form of current meter is preferred. It is, of course, impracticable to construct weirs on streams of considerable size, but dams already constructed are sometimes utilized for measuring discharge. Several meters are figured in Mr. Newell's paper, two types being shown,—the horizontal cup wheel and the propeller style. A favorite form is the latter, with a two-fluke wheel, used on a rod, or suspended by cord from a bridge or other support, or swung over a stream and lowered to any desired point by means of suitable light cables and trolleys. This meter records electrically, and, as Mr. Newell observes, has, like similar electrical devices, the disadvantage of getting out of order, when in the field, in the most aggravating manner. Long search was made for some form of electric battery convenient for field work,—light, portable, strong, and reliable. Nearly every kind of dry battery was tried, and given up in favor of the more cumbersome wet cell, which, though bulky and liable to breakage, could be depended upon. Finally a very small bisulphate of mercury battery (only about 2 × 1 in.), as made for medical purposes, seems to be satisfactory, if cleaned and recharged at short intervals. The meters are used from a bridge, a boat, or a suspended car. A bridge is most convenient, if its piers do not obstruct the current. At most important points, however, bridges are not available; then, if the stream is not too wide, a wire cable is stretched across and a boat attached to the cable by a travelling trolley. The meter is then used from the bow of the boat, usually from a rod allowing it to be placed at various depths. Meters are

tested by running them at known speeds through still water.

Wooden Bridges in Modern Practice.

ALTHOUGH the engineering text-books continue to give the usual matter about wooden bridges, it is seldom that they receive attention in current technical journalism or in the papers presented at the society meetings; and the common impression seems to be that they are interesting mainly from the historical point of view, and are now used only as temporary make-shifts or for insignificent spans. It is consequently refreshing to note that Mr. J. Parker Snow has taken the trouble to show what is now being done, as a matter of choice and in advanced practice. His paper on wooden-bridge construction on the Boston & Maine railroad (read before the Boston Society of Civil Engineers and published in the *Journal of the Association of Engineering Societies*, July, 1895) explains why the engineers of the progressive, well-equipped road to-day prefer wooden bridges—within due limitations, of course—to those of iron and steel, even where the best timber has to be brought long distances and where freights on metal are low.

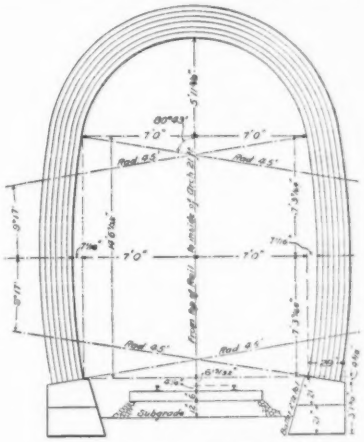
On the Boston & Maine there are 1085 wooden bridges out of a total of 1561, counting overhead as well as track bridges and everything of over 6 ft. span except stone culverts. While Mr. Snow admits that the proportion grows less yearly, still more than half the new structures built to replace old bridges are of wood. He enumerates pile trestles, plain stringer bridges, compound stringers of keyed timbers to get greater depth, pony trusses, and Town lattice bridges. The last named are of the most importance, on account of length of span. Mr. Snow considers the cost of well-built Howe trusses of considerable span about the same as that of iron bridges at present prices of material, which rules them out. For the Town lattices spruce is used mainly on the northern part of the system and Southern pine on the southern lines. Spruce, he says, is sufficiently durable when roofed in, and on account of its lightness is much better than Southern pine for lattices, though its softness and tendency to warp, and the difficulty of getting sticks of sufficient size, make it inferior for Howe truss work of magnitude. Although spruce exposed to the weather has a life of but about 6 or 7 years and Southern long-leaf pine 12 to 14, when roofed in and well ventilated either timber will last 40 to 50 years; and in the discussion of the paper Mr. B. W. Guppy cited cases of wooden railroad bridges lasting from 45 to over 50 years. The cost of various bridges for single-track of 120-ft. span is stated as follows: iron, $5300; Howe truss of Southern pine with iron angle blocks, $5000; spruce lattice, $3500. Below this point the advantage of wooden construction in point of cost will increase, and above it the advantage rapidly decreases to nothing. Details of lattice work and diagrams showing method of building are given very fully by Mr. Snow.

In the discussion of the paper Mr. Guppy added some interesting information as to wooden bridges, and the Town lattice in particular. He said that in use these bridges stand a great deal of abuse, and quoted instances of serious collisions and washouts which left them serviceable. He remarked upon one valuable property of a timber bridge,—its certainty of giving warning of approaching weakness,—which has kept the record of wooden truss bridges so clear from fatal disasters. It is not reasonably safe to use a light iron bridge until it is nearly worn out, but a wooden one may be used until its deterioration is rapidly approaching the end. Fire is the principal enemy of such bridges, but the danger has become much less since the introduction of coal-burning engines. Proper precautions are suggested.

Neither Mr. Snow or Mr. Guppy wish to be understood as preferring timber to iron or steel apart from the question of cost; but it must be admitted that, within reasonable limitations, they make out a strong case for wooden bridges, so that, far from being obsolete and in bad practice, the building of such bridges is a live business to-day, under conditions of fair competition.

Re-lining a Weakened Tunnel.

THE Patton tunnel, near Taswell, on the Louisville, Evansville & St. Louis railroad, has long been a source of annoyance, its wooden lining having caught fire some years ago, when large quantities of earth and rock fell in, stopping all traffic until it was cleared and the timber lining repaired,—a period of three months. Since then similar trouble has always been feared, it having been noticed that the material over the tunnel had become loosened almost to the top of the hill. It was supposed that the only remedy would be an open cut or a new tunnel. The *Railroad Gazette* (July 26) gives the following account of how Mr. T. A. Allen, chief engineer of the road, met the emergency by relining the old tunnel with brick. A section of the tunnel is shown in the accompanying cut. The line is single track, stone ballasted, having new oak ties laid with 90-lb. rails. The tunnel proper is 775 ft. long, although the entire length of the work in question was 1200 ft., there being, in addition to the tunnel, an embankment and entrance walls. The walls and arch are of vitrified brick and stone, the center of the arch being 21 ft. above the rails. The width of the tunnel is 15 ft., the walls being composed of six rings of brick. During the construction of the work, traffic on the road was not interrupted, the sides and roof of the tunnel being supported by temporary timbering. The track was temporarily supported on 12-in. × 12-in. stringers 10 ft. long between supports during the building of the invert. The bricks used were of the best quality, hard burned paving-brick, tested for 4000 lbs. pressure per square inch without crushing. They were laid in cement mortar in proportion of one part of cement to two of sand. The cement was required to show 100 lbs. tensile strength per square inch without breaking, 7 days after mixing. The bricks were laid with the English bond, having five stretcher courses to one header course. No headers were used in the arch. Concrete or clay was used for packing the space between the sides of the tunnel and the brick walls, the former being used for foundation beds for the walls and invert, when so specified.



The Patton Tunnel—L., E. & St. L. R. R.

The Canadian and American Sault Ste. Marie Canals.

SPEAKING of the recent formal opening for traffic of that important undertaking, the canal on the Canadian side of the "Soo," by the Dominion government, London *Transport* (July 10) explains that this waterway will give continuous navigation for about 2384 miles, from the head of Lake Superior to the sea,—and might add that it has the advantage of keeping this navigation within Dominion lines, while the American canal furnishes only a partial exit for American vessels within their own boundaries. *Transport* also gives some interesting historical notes, from which it appears that the waterway had its real beginning so far back as 1793, in a wooden lock constructed for the boats of the Montreal Fur Company. Development has been slow, but in May, 1893, work was commenced on the new canal and lock. The latter is 900 ft. long, 60 ft. wide, and 22 ft. deep below the lowest recorded river level. The masonry walls extend on each side 1106 ft., and they are 11 ft. wide at the top and 20 ft. wide at the bottom, while around the gates they have a uniform thickness of 25 ft. There are three sets of gates at the eastern end. One is a guard gate to be used only in

emptying for repairs; one is a spare set to be used in case of accident to the outer gate, the latter being in regular use. At the upper end there is a main and a guard gate. The draw-bridge over the Canadian lock has an opening of 90 ft. Across the island the canal is 3500 ft. long, 152 ft. wide at low-water level, and 145 ft. wide at the bottom. The low-water depth is 20 ft. The total cost involved by the construction of the canal is £4,000,000.

In this connection *Transport* also refers to the second and far larger lock on the American side, and gives some figures relating to it. This lock is to be 1124 ft. in length, or 800 ft. between the quoins of the main gates, and 100 ft. in width. The depth on the mitre sill is to be 21 ft. at ordinary low stages, and the lift 18 ft. The site has been excavated down to a base of solid rock, and the foundations for the walls and floors have been built up to the required height with concrete. The gates are to be of arch form, and will be built mainly of low steel. The lock will be filled from a pit in the floor of the upper gate chamber, and the water will enter the chamber from the culverts through two hundred and fourteen openings in the floor. The emptying valves are similarly placed against the down-stream face of the lower pit. To empty the lock the water passes from the pit through culverts to a similar pit just above the lower guard gates, which is open to the lower level. A guard crib of timber, 64 ft. long, 20 ft. wide, and 28 ft. high, filled with stone, is being placed at each end of each wall. The walls are to be 43½ ft. high above the level of the chamber. The coffer-dam is 1500 ft. long and 300 ft. wide.

CHLORIDE of zinc paint, although virtually a water-color, dries quickly and hard, so that it can be washed with soap and water when necessary, and will be found a preservative of wood, rendering it almost incombustible.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

11. The New Brooklyn Terminal Station of the Brooklyn Bridge (Details new 4-track, 2-island platform system, train sheds, tail switching). Ill. Eng News-July 4. 3400 w.

40. Expansion Bearings for Bridge Superstructures. Ill. George S. Morison (Description of bearings and motion stops). Ry Rev-July 6. 600 w.

89. The Substructure for the Third Avenue Bridge, New York City (Pier construction by caisson and coffer dam). Eng Rec-July 6. 1000 w.

235. New Bridge Specifications (General specifications for railroad bridges; proportion of parts). Eng Rec-July 13. Serial. 1st part. 1700 w.

407. Elevated Structure, Merchants Bridge Terminal R. R., St. Louis, Mo. Ill. H. P. Taussig (Working drawings and description). Eng News-July 18. 1500 w.

410. Stresses in Plate Girders. Ill. Henry Goldmark (Cor. Two cases; deck and trough girders). Eng News-July 15. 900 w.

439. Length of Angle Bars. Jerry Sullivan (How stresses act). Ry Rev-July 27. 1400 w.

†521. Wreck of the Connersville (Ind.) Bridge and Its Temporary Repair. Ill. Joseph Kemper (Low trestle by-way). Pro Eng Club of Phila-July. 1700 w.

557. The Newport and Cincinnati Bridge. Ill. (Brief description; elevations and sections. R R Gaz-Aug. 2. 350 w.

649. Double Swing Bridge at Columbus St., Cleveland, O. Ill. (Descriptive). Eng News-Aug. 8. 1400 w.

Canals, Rivers and Harbors.

85. Concerning the Cost of Ship-Canals (Suez, Corinth, Baltic, Manchester, Nicaragua compared). Eng News-July 11. 1800 w.

88. The Chicago Canal and Lake Commerce (Editorial. Effect of lowering lake levels). Ir Age-July 4. 700 w.

*173. Drainage in the Fens. Ill. (River aqueducts; scouring dredge; ditches). Engng-July 5. 2000 w.

*206. The Clyde Docks Improvements (Hydraulic, electric and steam cranes; dredging). Ir & Steel Tr Jour-July 6. 2000 w.

441. The Drainage Canal and Lake Levels (Conservative views as to effects). Ry Rev-July 27. 1400 w.

*479. Glasgow Docks and Harbor Works (Dredging; cranes; pumping plant). Eng, Lond-July 19. 2300 w.

*620. The Improvement of the Port of Havre and of the Navigation of the Estuary of the Seine. Ill. (Developing a sandy estuary). Eng, Lond-July 26. 4000 w.

*621. The Waterloo and City Electric Railway. Ill. (Map and detailed sections). Eng, Lond-July 26. Serial. 1st part. 2200 w.

We supply copies of these articles. See introductory.

661—$1.50. The Santa Ana Canal.—Discussion and Correspondence on Paper by William Ham. Hall (J. J. R. Croes, William Barclay Parsons, L. L. Tribus, James Duane, R. C. Gemmell, Franklin Riffle, Charles W. Greene, James D. Schuyler, David C. Henry, L. J. Le Conte and William Ham. Hall). Tr Am Soc Civ Eng–June. 13000 w.

*674. Recent Engineering Improvements of the Clyde Navigation Company. James Deas (Particulars of the dredging machinery, and especially of the recent additions thereto, and the quantities and cost of the dredging in the harbor and river, etc.; and description of the present equipment of the harbor of Glasgow). Ind & Ir–Aug. 2. Serial. 1st part. 3800 w.

*676. Harbor Development on the South Coast (Folkestone and Dover). Trans–Aug. 2. 2000 w.

679. The Atlantic Coastwise Canal Across New Jersey. From report of N. H. Hutton. R R Gaz–Aug. 9. 600 w.

Hydraulics.

86. The Hydraulic Pump. Ill. Robert Ferriday (Experiments on back water). Eng News–July 11. 1200 w.

233. The Milwaukee Water-Works New Intake (Construction; completion; costs). Eng Rec–July 13. 1600 w.

236. The Jerome Park Reservoir. Ill. (Amount of work and materials). Eng Rec–July 13. Serial. 1st part. 900 w.

337. New Hydraulic Formulæ. Marvin E. Sullivan (Based upon the system of unit coefficients; with new theories of flow, and of the eroding power of water). Eng & Con–July 12. Serial. 1st part. 1700 w.

338. High-Service Water System, Manchester, N. H. Ill. (Details of system). Eng Rec–July 20. 1200 w.

411. A Computer for Determining Flow in Pipes by Kutter's Formula. Ill. (Application). Eng News–July 18. 1100 w.

424. The Chicago Ship Building Co.'s New Dry Dock. Ill. (Coffer dam construction; side-on launching). Eng News–July 25. 1000 w.

427. Goulburn Dam, Victoria, Australia. Ill. (Reprint of a rare monograph). Eng News–July 25. 2700 w.

†517. Methods and Results of Stream Measurements by the United States Geological Survey. Ill. F. H. Newell (Gages; current meters; records; discussion). Pro Eng Club of Phila–July. 8000 w.

†519. Coffer-Dams. Ill. William H. Dechant (Crib-work construction; clamping; sinking; puddling. Discussion). Pro Eng Club of Phila–July. 2600 w.

Irrigation.

†299. On Keeping Irrigation Canals Clear of Silt. Robert Burton Buckley (River works; head sluices; head catch basin; double sluice and setting tank system). Ind & East Eng–June 15. 1300 w.

452.—$1. A New Method of Determining Co-Efficients of Flow and of Resistance in Pipes and in Open Channels, and New Formulæ for Head, Diameter, Mean Hydraulic Radius, Velocity, etc., Based on This New Theory. Marvin E. Sullivan, with Discussion by Engineers (Mathematical). Am Soc Ir Eng–Jan. 8500 w.

Miscellany.

14. The Meaning of Elastic Limit in Steel Specifications (Experiments; specifications. Comments by William R. Webster. Reply by A. C. Cunningham). Eng News–July 4. 3000 w.

31. Adulterated Portland Cement and Blast Furnace Slag. A. D. Elbers (Chemical reactions. Practical results). Eng & Min Jour–July 6. 2200 w.

44. The Civil Engineer and His Work (Editorial reviews and comments on Mr. Morison's paper). Ry Rev–July 6. 1200 w.

†79. An Apparatus for Experimenting with the Laws of Flexure of Beams. Ill. James L. Greenleaf (Description of apparatus. Mathematical treatment of results). Jour Frank Inst–July. 1600 w.

231. The Effects of Low Temperature on Iron and Steel. Editorial (Inconclusive data and conflicting testimony). Eng Rec–July 13. 1200 w.

232. American Portland Cement. William G. Hartranft, with Editorial (History; merits; composition). Eng Rec–July 13. 3000 w.

234. Tunnel Disaster in Australia (Failure shield-driven heading; plugging with clay bags and loose clay). Eng Rec–July 13. 1400 w.

239. Hydraulic Caisson Foundations. Ill. (Site; telescopic steel cylinders; sinking; clearing; masonry piles). Eng Rec–July 13. 3300 w.

*353. Working in Compressed Air (Physiological effects). Engng, Lond–July 12. 1600 w.

428. The Elastic Limit and the Yield-Point (Literature reviewed. Comment by G. C. Henning). Eng News–July 25. 10500 w.

508. Hydraulic Caisson Sinking for Foundation Piers Ill. (Open steel cylinders; water jets). Sci Am–Aug. 3. 600 w.

*631. The Civil Engineer (Editorial. The meaning of the term defined). Engng, Lond–July 26. 2200 w.

†655. "The True Column Formula" an Impossibility. James L. Greenleaf (Expresses the belief that a finite mind is incapable of stating a true column formula). Sch of Mines Quar–July. 1800 w.

659.—$1.50. Address of George S. Morison at the Annual Convention at the Hotel Pemberton, Hull, Mass. Tr Am Soc Civ Eng–June. 8400 w.

660.—$1.50. Painting of Iron Structures Exposed to Weather. E. Gerber, with Discussion (The most important recent contribution to the subject with voluminous correspondence from a large number of prominent engineers). Tr Am Soc Civ Eng–June. 55000 w.

DOMESTIC ENGINEERING

Fallacies of the Trap Vent Pipe System.

MR. J. W. HUGHES, in *Architecture and Building* (July 6), asserts that "complete and continuous ventilation through every part of a waste system is the Utopian ideal of the sanitary expert"; and he calls "the popular belief" that "such a circulation is secured by the observance of the commonly-accepted rules for house drainage" a delusion. He says: "It is simply impossible to maintain such circulation in the several parts of a pipe system constructed in accordance with these rules, especially where there are two or more vertical lines of pipe, where there are fixtures on two or more floors, or where there are many fixtures connected with the same system.

"It will be observed that the entire drainage system of each building, whether large or small, is discharged through a single outlet, and usually, though not always, disconnected from the sewer at the cellar wall by a running trap, with a fresh-air inlet connected with the drain on the house side of the trap, and extending to the outer air at the street curb. But the presence or absence of this trap and foot vent is not material to the question at issue. It must be remembered that circulation through these pipes is mainly dependent on the difference of temperature between the outer air and the air in the pipes. In winter, when the outer air is cold and the air in the pipes is warm, an upward current may be traced in one or more of the rising lines, while those more remote will show little or no circulation, for the reason that the single source of supply—the fresh-air inlet or the drain—is too limited to meet the demand in several rising lines, in which there is liable to be considerable difference of resistance. In summer, when the air in the pipes is frequently colder than the outer air, either complete stagnation or a positive downward flow will occur, usually the latter. Hence it is evident that much of the waste system will always be filled with dead air, moved only fitfully by the discharge of fixtures or changes of temperature, and this condition will be the more marked in large buildings where there are many rising lines of pipes. But, even when an upward air current does exist in the soil pipe, no movement of the air in the branches between the soil pipe and vent pipe will occur, from the fact that no provision is made to supply the increased volume of air necessary to establish and maintain such current."

Fig. 1.

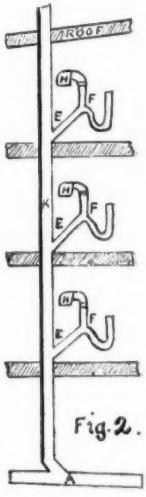


Fig. 2.

To further demonstrate the accuracy of these views the accompanying diagrams are used. Fig. 1 illustrates the usual system. "*A* represents the horizontal soil pipe or drain through which all the air must pass before it reaches the rising lines. If the vertical soil pipe *K* is 4 in. in diameter and the trap vent pipe 3 in., then 36 per cent. of the air is diverted at *B* into the vent pipe, where it ceases to perform any useful function. Hence it is obvious that the upper current and æration in the soil pipe above this point will

be reduced more than one-third. At *E, E, E,* are three branches to which are attached traps, vented at *F, F, F,* into the vent pipe at *G, G, G,* in the usual way. As the rising current of air in the two pipes is necessarily equal in pressure, density, etc., and the capacity of the soil pipe is of uniform calibre to the top, it will require all its contained air to maintain an equal pressure and air current with that of the vent pipe; and, unless the vent pipe were enlarged above each branch, it would be incapable of receiving any of the soil pipe because such increase would destroy its equilibrium with that of the soil pipe.

"If the soil pipe were reduced in size at *E, E, E,* and the vent pipe correspondingly increased at *G, G, G,* then the amount of air proportioned to the changed capacities in the pipes would be diverted at each of the branches from the soil pipe at *E, E, E* to the vent pipe at *G, G, G;* but this would so reduce the upper portion of the soilpipe, as to render it incapable of performing its function. Thus the absurdity of the theory becomes self-evident.

"On the other hand, if each of the traps were vented automatically, as shown in Fig. 2, since the same amount of air must pass through the horizontal soil pipe in each instance and as none would be diverted from it at any point, the æration and air current would be 50 per cent. greater than in the corresponding soil pipe in Fig. 1. But the actual difference would be much greater than this, because every time there is a slight minus pressure in the pipe caused by the discharge of a fixture, or by a strong air current passing over the top of the soil pipe, large volumes of air would be drawn into the pipe through the automatic vents, and thus leave the branches filled with fresh air, which is impossible under the trap vent pipe system. Now let us suppose the horizontal soil pipe extended, and other rising lines attached; certainly very little circulation could be expected in any of these, for the simple reason that the first rising line would furnish capacity and the most direct route for the escape of the received air. Here again great advantage is secured by venting the traps automatically, since much fresh air is thus drawn into the pipes, while little or no circulation is possible under the trap vent pipe system. These facts show the advantage of this method over all others as a means of æration of the waste system, while the exhaustive researches in trap siphonage by Prof. James E. Denton, in the department of tests at the Stevens' Institute of Technology, demonstrate beyond question the practical superiority of a properly-constructed automatic device as a means that will preserve the trap seal against siphonage in the conditions occurring in plumbing practice."

Country Roads and Roadsides.

As a feature of landscape gardening, the treatment of country roads and roadsides is editorially considered in *Garden and Forest* (July 10) as meriting greater attention than has hitherto been bestowed upon it. Beyond the fact that a road should furnish good wheeling and footing, it may be made a delight by its borders. Through cultivated land borders of turf with suitable trees are recommended, but these borders should be kept trim and neat. In cases where the features of "the country are rugged and stony, undoubtedly the greatest beauty is secured if native shrubs and trees are allowed to take possession of the borders, and the axe is withheld unti they become too dense or aggressive."

As illustrating the possibilities for pleasurable effects in the treatment of by-roads, a bit of road, not more than a mile in length, is described in its summer aspect. "In the first place, it is not a highway of travel, and, therefore, it is only wide enough to allow two vehicles to pass. This is a distinct advantage. A broad road always has a depressing effect, and the wayfarer feels lonesome on it, as he does on any other desert. The more nearly a rural road is obliterated by its surroundings, the more delightful it is, and this is especially true of a by-road which offers a sense of seclusion as one of its principal charms. And, again, a narrow road can be more easily and cheaply kept in repair, since every additional square yard of surface requires so much more work, and this is an important matter in

the community where the road-tax is a heavy item of expense. This particular road, after emerging from a piece of timber, climbs a hill, and then winds about some others until it drops into the rich bottom-lands of a small river and joins an important highway. On either side of it trees and shrubs in great variety take care of themselves; and in the first week of July, when the foliage has been washed clean by the rains, this border in its general effect was singularly beautiful. In some places there were thickets higher than a carriage-top, through which the eye could hardly penetrate; while just beyond were openings to give glimpses of a picturesque, rolling country, with a mountain range for a sky-line. The masses of foliage projected and retreated in the most natural way, without a single hard line or discordant color, now shrinking into deep shadows and again boldly courting the full sunlight, so that to one looking forward the disappearance of the road to right or left always seemed an invitation to prospects still more fair."

"The details of this border were quite as interesting as its general attractiveness. Here were elders in the beauty of their bloom, and white blackberry-blossoms close beside the red and black shining fruit of the raspberries. Close along the roadbed the clustered flowers of redroot were mingled with wild roses, and here and there among these native wildings was an occasional sweetbrier which had strayed from some old homestead. The buds of the smooth sumach, in their tall panicles, were just yellowing into bloom, while the pink fruit of the staghorn sumach was already appearing. The black alders were showing inconspicuous flowers among the dark green foliage, and at one point, where the ground was moist, a mass of white azaleas fairly glittered against the smooth clean leaves of the spice-bush. Thorns and cornels, choke-cherries and hazels and huckleberries, were in fruit, and the hardhack was just opening its closely-set rosy flowers. Along with the shrubs were young trees of various species struggling to assert themselves. There were little tulip-trees with foliage much larger than in mature specimens; oaks and maples of various species, with tints of foliage only seen in young individuals; ash and elm, and here and there a hornbeam, one of which, thrusting out its horizontal branches above some low-growing viburnums, was especially picturesque; hickories, butternuts, chestnuts, basswood, and sassafras; and over all these clambered the wild grape and moon-seed, smilax, bittersweet and clematis, with Virginia creeper festooning the fence-rows or hanging from the limbs of the trees which had here and there been allowed to reach natural size."

This graphic description will recall to many readers similar beauties in favorite drives and rambles. Of course, as the season moves, the variety of plants in bloom will change in character, but it is asserted that "there is not a day in the year when one who walks or drives over this short bit of road cannot find delight for his eye and food for his imagination." Many such bits of road could be made almost as effective as parks for places of pleasurable resort, and this could be done at a trifling cost, since the ground costs nothing for this special purpose.

Tests of Heat Insulation.

A RECENT experiment with three kinds of pipe coverings designed for preventing the escape of heat from steam and hot-water pipes, as in refrigerating machines, etc., is described in a recent number of the *Boston Journal of Commerce*. This experiment was made by a Cincinnati chemist, for the established purpose of determining comparative value of the coverings as insulating materials. The experiment is worth noticing, because, while it happens to be of the crudest possible sort, its results are being published in various journals as true indications of the relative value of these coverings, all of which are in use. Next to the duty of publishing the truth that of guarding the public against error should be respected by every technical journal. When an experimenter abandons well-known methods, generally accepted as reliable by the highest scientific authorities, for some new and untried method of his own, and, without any check upon the

results, publishes them as authoritative, the inferences may be drawn that the results are unreliable, and that his experiments were performed with a view to establish a preconceived notion. It is, of course, possible that accurate results could be attained in this way; but the possibility of failure is so great that scientific people would not accept the results without verification, and common prudence would withhold them until corroborative proof of their accuracy could be obtained.

The experiments in question were performed as described further on. The old method of condensation, hitherto authoritatively regarded as the best known for determining loss of heat, is deliberately set aside, and results obtained by it, and by the same experimenter, are discarded in favor of the following method.

"A 2-in. pipe carrying steam at 60 lbs. pressure was selected, and a piece of covering 13 in. long placed upon it, and this covering inclosed in a box with a glass cover, and inside the box a thermometer was placed so that the temperature in this small box could be read. Three of these boxes were placed upon the pipe, 13 in. long, covered with the covering to be tested. The box having the lowest temperature was supposed to have the most efficient covering, on the supposition that the covering in that box prevented less heat passing from the pipe to the box."

The results are given, but we will not quote them, believing that in so doing we might do an unintentional injustice. Varying results are assigned as the reason for abandoning the old and tried way; but we notice that in the new method the results also varied, and that an average had to be struck. Those interested in the purchase and use of composition boiler coverings should be on their guard against accepting statements based on such crude tests, if, indeed, they ought to be called tests at all.

Heating by Gas.

THE results of practice in heating by gas in Germany are very instructive. A rather complete summary of these results is given in the *Sanitary Record* (August 2). From this summary it appears that the rapid extension of electric lighting in Germany has given an impulse to the employment of the existing plant, capital, and skill hitherto devoted to gas lighting in other directions and to the utilization of gas as a source of heat and power. The substitution of water gas for coal gas, which has been proposed on the ground of economy, has not given encouraging results, the heating power of hydrogen being so much lower than that of carbon; but there appears to be a remarkable difference among different samples of gas used for heating, not only from different towns, but from the same works at different hours of the day. These variations are altogether unaccounted for, and it would have been interesting if something had been said in our contemporary's summary upon this subject. The heat of combustion, given in heat units for the different ingredients of gas gives a total of 5241 heat units. "This total of 5241 heat units from 100 volumes of gas is attained only when the whole of the products of combustion escape into the room, which in practice is, of course, inadmissible; but the effective amount depends on the construction of the stoves, and may in some cases be as low as 29 per cent. of the whole."

This shows a remarkable deficiency in the appliances for the combustion of gas, more than two-thirds of the effect being wasted. However, in some of the better kinds of apparatus the efficiency is very much greater, ranging between 60 per cent. and 85 per cent. of the whole. Dr. Bueb of Dessau has determined the heat values of a number of gases by a Tunker's calorimeter, and, after deducting the loss by the condensation of the water vapor, he found the heating value of the gas of Dessau to be 4650 heat units, that of the gas of Erfurt to be 4850 heat units, the gas of Halle 5011 heat units, that of Leipsig 4797 heat units, that of Bremen 5434 heat units, and that of Frankfurt-on-Main 6700 heat units. These gases are all made from coal, and they may be considered as ordinary coal gases. In other kinds of gas very much greater divergencies were exhibited, thus: oil gas from Riebeck's works had a heat value of 9882 heat units; pure cannel gas at Bremen

had a heat value of 5963; water gas made at Frankfort had a heat value of 2385 heat units. Dawson's gas had a value of 1312 heat units. It will be seen from these figures that the calorific value of various kinds of gas may vary through a range of from 1 to 9, taking the least value as a basis of comparison. The commercial success of gas heating depends on the cost of production, the heating power, and the amount of effective heat obtained in the particular stove used. It would, therefore, seem that gas of the smaller calorific value named in the last above-mentioned variety could under no circumstances prove to be a commercial success. For complete combustion eleven volumes of air for one volume of gas are needed, and this amount, mixed with the gas before burning, produces the blue "*Bunsen*" flame.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

90. Hot Water Heating in a Chicago Apartment House. Ill. (Descriptive of plant in a building 60x80 feet, and three stories above basement). Eng Rec–July 6. 1000 w.

240. The Union Depot at St. Louis. Ill. Serial. 1st part (Descriptive of heating and ventilation). Eng Rec–July 13. 1300 w.

285. "A Breezy Editorial." From the Architects Electrical Bulletin. Elec Rev–July 17. 800 w.

334. Heating and Ventilation of the Asylum for the Chronic Insane at Wernersville, Pa. Ill. (Descriptive). Heat & Ven–July 15. 2500 w.

335. Economy in Furnace Heating. William G. Snow (Coal saving and ventilation regulating with warm-air furnaces). Heat & Ven–July 15. 1300 w.

*671. Heating by Gas (Progress in Germany). San Rec–Aug. 2. 400 w.

Landscape Gardening.

103. Country Roads and Roadsides. Editorial. Gar & For–July 10. 1500 w.

187. Old-fashioned Gardens. Editorial (Their charm. Plants that used to be cultivated, etc.) Gar & For–July 17. 2000 w.

188. Midsummer Care of Chrysanthemums. T. D. Hatfield. Gar & For–July 17. 700 w.

189. Some Showy Perennials. R. Cameron. Gar & For–July 17. 800 w.

*317. Park and Garden Architecture. T. H. Mawson (Everything should be designed in harmony). Builder, Lond–July 13. 2400 w.

468. Japanese Vegetation in California. Charles Howard Shinn (Tendency toward extensive planting of Japanese trees, shrubs and flowers grows more and more evident). Gar & For–July 31. 1000 w.

Plumbing and Gas Fitting.

52. Some Fallacies of the Trap Vent Pipe System. Ill. J. W. Hughes (An attempt to prove that complete and continuous ventilation throughout every part of a waste system is impossible, or, at least impracticable). Arch & Build–July 6. 1100 w.

*135. The Apprenticeship Question (Speaks of the need of apprentices and of a movement to re-establish the old system in the plumbing trade). Plumb and Dec–July. 1400 w.

137. Country Plumbing. Ill. (In form of answer to a correspondent treats practically the plumbing of small country houses,—a subject on which practical literature is meagre. A useful article). Met Work–July 13. 1800 w.

257. Municipal Legislation. John L. E. Firmin (To what extent may municipal legislation be relied upon to enhance the standing of master plumbers? Is it not in some cases a bolster and endorsement of the unworthy?) San Plumb–July 15. 1300 w.

258. Unity. Edward D. Schuster (An argument against the bidding as sub-contractor by master plumbers. Such sub-letting is shown to be a great evil in the trade). San Plumb–July 15. 1400 w.

259. The National Association of Master Plumbers—Its Influence and Benefits. G. T. Ahrens (Read at 7th An. Con. of the Master Steam and Hot Water Fitters Asso. of the U. S.) San Plumb–July 15. 1600 w.

Miscellany.

†18. Gas-Contaminated Water (An account of contamination of water by gas in an 8-story business building, its cause and remedy). San–July. 400 w.

*228. The Products of Combustion of Coal Gas, from the Hygienic Point of View (An account of an investigation made by H. Chr. Geelmuyden in the laboratory of the Physiological Institute of the University of Christiana). Gas Wld–July 6. 3300 w.

*242. Disinfectors and Disinfectants, 1874-95: A Contrast. Ill. Joseph Priestly (Besides discussing the need and nature of disinfectants, describes a number of appliances and machines for disinfecting articles which have been exposed to contagion and septic influences). San Rec–July 5. 3400 w.

435. The Plumbers' School at Aue, Saxony (From a recent consular report). Arch & Build–July 27. 900 w.

*488. Special Report on a Case of Food Poisoning at Homerton. J. King-Warry (Poisoning of food attributed to emanations from foul drains). San Rec–July 19. 1100 w.

We supply copies of these articles. See Introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Electric Power in Manufactories.

THE application of electricity as a means of distributing power in manufacturing establishments, in lieu of shafting, belting, and gearing, is beginning to attract attention to a degree somewhat commensurate with its importance. A recent paper on the subject by Messrs. Crocker, Bendikt, and Ormsbee, read at the Niagara meeting of the Electrical Engineers, is published in part in the *Electrical World* (July 13). Actual power tests made in several machine-shops and New England mills are given in considerable detail. These show that the average power consumed in the ordinary operation of certain machines is as follows: large boring machine, 1.43 h. p.; drill-press, 2.9 h. p.; small punch-press, 0.71 h. p.; group of one lathe and one milling machine, 1.47 to 2.28 h. p.; group of one small milling-machine, two 10-in. lathes, one grind-stone, one drill-press, one small punch-press, 0.86 h. p. In a group of seven lathes and one grindstone driven by a 3 h. p. motor, it was found that 1.14 h. p. was required to run one lathe, while four lathes could be run with 1.8 h. p.,—an increase of only 63 per cent. This result is due to the friction of the countershaft. A large planer, 120 in. between posts by 108 in. high by 22 ft. bed, took 4.76 h. p. on the cut, 5.73 h. p. on the return, and 21.6 h. p. on the reversal; average, 5.11 h. p. A cylinder-boring machine averaged 4.17 h. p. These results show that the actual power required to drive heavy machine-tools has heretofore been considerably over-estimated. In the case of the large planer, although the motor was overloaded 50 per cent. upon the reversal of the bed, the average load was only one-third the rated full load. The question whether machine tools should be driven individually by separate motors, or in groups, one motor driving each group, does not seem to admit of a general solution. Electric motors are very successfully used in calico-printing. The problem of running this class of machinery has proved a very difficult one, inasmuch as the motor must be capable of running at a number of different speeds and running constantly at any given speed with a variable load. It is claimed that in this class of work the increase in production with the electric motors amounted to more than 25 per cent., while the quantity of inferior product was at the same time considerably reduced. This is a very important matter, as the men in charge of printing machines are skilled workmen of a high order, and a small saving in wages for a given production is of more value than a considerable saving in power.

Underground Wires in Boston.

IN the *Electrical World* (July 20) Mr. J. E. Talbot has an excellent article, giving full particulars of the condition, progress, and prospects of the work now going on in Boston in the way of placing the electric lines underground in the central portions of the city. Although the work here did not begin under legal compulsion until 1894, this delay served a good purpose, as it enabled Boston to avoid many costly mistakes which were unavoidable in New York and Chicago, in which cities those who undertook somewhat hastily to do the work found that they had much to learn. From September, 1894, to February, 1895, 400,000 ft. of duct were laid. The telephone companies alone have now over 11,000 miles of underground wire in Boston, much of which had been laid before the compulsory legislation of 1894 went into effect. The total amount of duct in the city, according to the latest report of the commissioner, is over 2,000,000 ft., in which are laid 1,817,000 ft. of cable, about one-third of which is used for telegraphic and telephonic service. The conduits are not, as in New York, owned by the municipality, but are built and owned by the operating companies under the supervision of a municipal

officer, subject to an appeal to a board consisting of the city engineer, the superintendent of streets, and the chairman of the board of fire commissioners. In many cases, by joint agreement, several electric companies occupy the same trench, in order to avoid unnecessary opening of streets. The inevitable cost has not been increased by needlessly harsh or heroic measures. The commissioner has carried out the provisions of the law with tact, discretion, and courtesy, and the representatives of the various electrical companies have never acted in an obstructive or unwilling manner. This, unfortunately, has not been the case in many other cities which might be mentioned.

Electric vs. Steam Locomotives.

AN editorial on this subject in *The Street Railway Journal* for July expresses the belief that the substitution of electric for steam locomotives on trunk lines is not a near probability. The question of such substitution is, however, under active discussion, and the sensational accounts of trials of electric locomotives and their remarkable performance has led an oversanguine public to believe that we are on the very eve of such a revolution. The editorial quoted expresses the view that this resolution "is far in the distance, and not likely to come about in this generation, at least. Such a road as the New York Central between New York and Buffalo is, of course, much nearer the electric age than roads like the Northern Pacific, the Union Pacific, or even the roads between Chicago and St. Louis, because, for its entire distance, it passes through one of the most populous sections in the country,—an unbroken chain of large cities 2 hours apart, of smaller cities at regular intervals in between, and of other townships and settlements of various sizes hardly 10 minutes apart. But power stations cannot profitably be established at intervals of 10, 20, or even 50 miles to serve only four or five trains an hour. There must be practically continuous traffic for from 15 to 20 hours a day, if the full advantages of the generation and distribution of power on the central station plan are to be realized; for it must be remembered that our steam locomotives are, on the whole, highly efficient machines, and cannot be replaced by electric locomotives for the same service without the very closest figuring of costs, and until a certain magnitude is reached in the scale of operations. In other words, this entire problem of the adaptation of electricity to the larger field of railway work is dependent almost entirely upon the magnitude of traffic possible to be obtained, not upon relative economies in operation."

Telegraphic Line Construction.

AT a recent convention of railroad telegraph superintendents in Montreal, W. F. Taylor of the Pennsylvania Railroad read an excellent paper on the construction of telegraph lines, which is printed in abstract in the *Railroad Gazette* (July 5) It certainly seems amazing that so little real progress has been made during the last quarter of a century in this most important branch of electrical engineering. Mr. Taylor, however, seems to have touched upon most of the really essential points in line construction. Poles, he says, should never be less than 22 in. in circumference at the top, or be set less than 5 ft. in the ground. The tendency to use unduly high poles was deprecated; the shortest possible poles should always be used. The lower wire need not be over 10 ft. from the ground along the railroad location, except at highway crossings, where it should be raised to 22 ft. or more. At each end of curves exceeding three degrees, two or three poles should be well guyed or braced, and on long tangents every tenth pole should be head-guyed. More attention should be paid to the matter of double-pole construction. No. 8 iron wire, the size ordinarily used, should not be strained over 200 lbs.; the usual practice is to strain it to nearly twice that amount, which leaves a very small factor of safety. Tests show the strength of an unsoldered twist-joint to be only 55 per cent. of that of the solid wire, while a soldered joint of the same type has an excess of strength. In the discussion which followed the paper, much stress was

laid on the fact that the railroad managers did not pay the attention they should to the requirements of good telegraphic construction. The suggestion was made that in places much exposed to the effect of storms a line will stand better if built in an unsymmetrical manner, so as to eliminate the effects of harmonic vibrations produced by the action of the wind upon the wires.

Street-Railway Financiering.

A SPECIAL issue of the *Street Railway Journal* (July) contains what is apparently a complete summary (reproduced in our department of railroading) of the statistics of the street railways of the United States. There are 976 roads with a total mileage of 13,588, of which 10,363 are operated by electricity, 1914 by animal power, 632 by cable, and 679 by other motors. The number of cars is 44,745. The aggregate capital stock is $748,014,206, and the funded debt $552,125,505. Thus the aggregate liabilities per mile, of all the roads, reaches the enormous sum of $95,600. These figures make it plain to a demonstration, that the majority of the street-railway building of the past few years has been the work of professional speculators. Nothing can be more certain than that there must come, within a short time, a severe financial crisis in this species of property. One of the most thoroughly constructed, complete, and profitable street-railway systems within our knowledge is capitalized at only $30,000 of stock and bonds per mile of track. In 1893 the average capitalization of all the steam railroads of the United States per track mile was $28,513 in stock and $31,119 in bonds,—a total of $59,632. A recent article in *Electricity* (June 12) illustrates the methods of the street-railway boomers by giving facts and figures of a typical example. It appears from this article that in 1890 a certain thriving municipality, having a population of 36,000, rejoiced in the possession of a system of horse railways capitalized at $250,000. Certain promoters, apparently not unconnected with a prominent electrical manufacturing company, took hold of the system, equipped it with electricity, capitalized it at $750,000, and issued $750,000 bonds on top of that. Then, by the aid of a new set of promoters, a consolidation was effected with another line extending 10 miles through a wilderness to a hamlet of perhaps five hundred inhabitants, on which $491,000 of bonds had been issued, although the total gross earnings of the line thus absorbed were less than one-third of the interest on the bonds. Bonds amounting to $1,500,000 were issued on the consolidated property, $1,250,000 of which are said to have been disposed of to "investors." Therefore the total liabilities of the consolidated concern up to date are apparently at least $2,250,000, which is certainly quite enough for a town of thirty-six thousand inhabitants. There is every reason to believe that this scheme, or some similar one, has been worked to a greater or less extent in a great many other places in the United States; and, when the defrauded bondholders wake up, as they will in time, there is likely to be a considerable uproar.

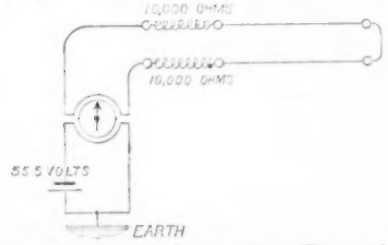
Trolley-Wires and Lightning.

IN a communication to the *Electrical Engineer* (July 21) D. B. Grandy, a well-known electrician of St. Louis, calls attention to the fact that in the summer of 1894, and even to a greater extent during the present summer, the switchboard of the central telegraph office in that city has been entirely free from electrical disturbances, in marked contrast to preceding years, when the blowing of fuses and the burning of instruments were matters of very frequent occurrence. He states that within a few miles of the city the electrical storms have been more frequent and more destructive the present year than ordinarily. He suggests that the extension of trolley-wires throughout the city during the past 2 years may explain the phenomenon. There can be little doubt that such is the case. It would be difficult to contrive a more effective means of equalizing excessive electric tension between the air and the earth, which is the accepted cause of electrical disturbances, than a network of suspended trolley wires, grounded not only at each end, but

through every car in transit upon the route. So effective is this protection that a seat in a trolley-car is probably the very safest place in the world during a thunder-storm. Nor is it worth while to jump overboard in case the lightning blows out a fuse and creates an explosion, as the passengers did one day in an open car in Boston; if one has time to jump, the danger, if there was any, has passed away.

Testing Telegraphic Circuits.

IN a widely-extended telegraphic system the maintenance of a perfect service demands that every line shall be tested each day before the opening of business, especially with reference to its condition of insulation, technically known as "insulation resistance." Heretofore this has usually been done by sending a current of known potential from the testing station over each wire in succession, and registering the effect of such current at the distant station upon a tangent galvanometer of carefully-estimated sensitiveness. This method is not free from liability to considerable error, but has the advantage of being very expeditiously applied. In the *Journal* of the Institution of Electrical Engineers (London, July,) Mr. W. H. Preece describes a new method of making such tests, devised by Mr. A. Eden of the post office and recently adopted in the British government service, which appears to present important advantages over the old method. At the head office a carefully-determined electromotive force of 55.5 volts is employed in conjunction with a differentially-



wound tangent galvanometer. The positive pole of the testing battery is grounded, and the testing current is transmitted from the negative pole through one coil of the galvanometer and a resistance of 10,000 ohms, out to the distant station and back through the two wires looped together at that point (see figure) returning through a second resistance of 10,000 ohms and the other coil of the galvanometer to earth. If the insulation were perfect, the currents through the opposing coils of the galvanometer would be equal, and the needle would stand at zero; while any difference between the outgoing and returning currents, due to loss through defective insulation on the line, must be exactly indicated by a corresponding deflection, the mean value of insulation resistance corresponding to each angle of deflection being given in a set of tables. Any abnormal leakage is thus detected, and the precise locality of the fault may be found by at once applying the ordinary "bridge test," for which the circuits are already properly connected. It may even be estimated with sufficient accuracy for practical purposes by the original apparatus, by removing the 10,000-ohm resistances, observing the direction and extent of the deflection upon the differential galvanometer, and applying the well-known loop formula to the result. The importance of maintaining a high standard of insulation is far more important where high-speed systems of transmission, like the Wheatstone automatic, are used, and hence the British post office has now adopted for such lines a minimum standard of one megohm per mile of insulation resistance.

Electric Plant at the Baltimore Tunnel.

A CAREFULLY-WRITTEN and well-illustrated description of the electric locomotives and plant of the new Belt-line tunnel in Baltimore is given in the *Electrical Engineer* (July 10). From this we learn that the power-plant consists of four 500-k. w. direct coupled generators, of the iron-clad armature type, compounded so as to give 600 volts at no load and 700 volts at full load. The working conductor has a cross-section equivalent to 1,000,000 circular mils. The distance over which the electric traction operates is about 15,000 ft., the length of the tunnel proper being 7339 ft. The electric locomotive

though to ordinary eyes a far less handsome machine than the modern steam locomotive, is, as the photographic illustration shows, by no means the ungainly monster that some of the accounts hitherto published might lead one to believe. It has two trucks, each fitted with two driving-axles and two electric motors. The weight on the eight drivers is 96 tons, and the ordinary drawbar-pull 42,000 lbs., which is capable of increase at starting to 60,000 lbs. The four motors are flexibly supported, and have each six poles and six sets of carbon brushes, four of which may be removed in emergency, without disabling the motor. Each motor is rated at 360 h. p., and takes a normal current of 900 amperes. The working conductors are placed overhead, and consist of two 3-in. iron Z-bars each, which are riveted to a cover plate so as to form a sort of reversed iron trough, within which slides the contact-shoe attached to the locomotive. This is of brass, and is mounted upon a jointed parallelogram of rigid bars affixed to the top of the cab, the whole system being capable of lateral deflection to allow for inequalities in the alignment of the track or working conductors. Some little trouble was encountered in the working of this apparatus during the preliminary experiments, but this appears to have been overcome, and, according to the latest advices, the performance of the apparatus is altogether satisfactory.

An Elementary Science Lesson.

WE regret to observe that the technical matter which appears in the columns of our esteemed contemporaries devoted to the advancement of electrical science is not always edited with the conscientious intelligence that could be wished. For example, one of these journals, whose name we refrain from mentioning, gave some time since an illustrated account of a newly-invented primary battery,—a fruitful subject of "invention" on the part of half-fledged scientists for at least two generations. After remarking that "attempts at increasing the output of batteries have been in the past devoted almost exclusively to increasing the ampere capacity to the practical neglect of the quest for increasing the voltage," the writer of the article goes on to say that he has had an opportunity of inspecting and testing the new cell, and in consequence of such inspection and test he ventures the opinion that it embodies a "genuine advance in battery work." The delightful absurdity of this solemn asseveration will be apparent, when it is stated that the alleged improvement consists in placing three pairs of zincs and carbons in a single cell, these being connected in series and all immersed in one and the same body of liquid. Considerable correspondence in the way of discussion, pro and con, of the "theory" of this valuable organization has been printed, which, like the sea-serpent stories of the daily press, may serve to enliven matters during the dull season; but in the *Electrical Engineer* of July 10 Professor W. A. Anthony ruthlessly analyses the action of the cell, and shows that the only possible advantage of the arrangement is the facility of handling a gallon or two of solution in one vessel instead of three, while, on the other hand, if the cell is used with any regard to efficiency, the internal leakage or waste current must necessarily be equal to the useful current, and hence the consumption of material must ordinarily be about double that of the ordinary cell. It is certainly to be regretted that people should be misled, as they often are, into wasting effort and money in the promotion of "inventions" of this type, by reason of a quasi-endorsement in the columns of presumably trustworthy technical journals.

Electricity in the Blacksmith's Shop.

ONE by one, in this age of steam and electricity, the picturesque features of the old-time industries are passing away forever. A recent number of the *Electrical Engineer* (July 17) gives a well-executed photographic reproduction of the interior of a typical rural blacksmith's shop. In the foreground may be seen the anvil and the tub in which the hot irons are cooled, while in the shadows of the background we discern the forge with its chimney and bellows,—the former, alas! serving now

apparently only as a convenient place of deposit for old iron and other litter usually found about such establishments, and the latter evidently covered with dust and cobwebs. A moment's inspection discloses to the eye of the initiated that here too electricity has been getting in its iconoclastic work. A rough board nailed to the disused chimney supports a piece of mechanism which we recognize as a double-pole electric switch, and from this insulated wires extend to a rectangular wooden tank standing on four legs near the anvil, looking not unlike a horse trough, which, the text informs us, is filled with an aqueous solution of washing-soda and borax, and constitutes the modern substitute for the forge fire hitherto assumed (but erroneously, as it now appears) by the Tubal-Cain and his worthy successors to be one of the essentials of an iron-worker's outfit. All that is necessary, we are informed, is to attach one of the circuit-wires to the clamp which grasps the piece of iron to be heated, thrust the latter into the solution, and turn on the current. Electrolysis at once takes place all over the surface of the metal in contact with the surface of the solution, and hydrogen gas is disengaged and takes fire, imparting its heat to the metal and quickly bringing it to any required temperature. The photograph illustrates a horse-shoeing establishment at Niagara Falls, the liquid forge deriving its operating current from a dynamo driven by the water of the Niagara river. With electric current costing 15 cts. per k. w. hour, the cost of preparing a horseshoe by this process is found to be 2.32 cts. as against 5.58 cents with coal at $5 per ton, while the absence of scale or oxid is said to effect a material improvement in the quality of the product.

SOME important considerations relative to street-lighting were presented by Mr. George Cutter in a paper read before the Northwestern Electrical Association, given in the *Electrical Engineer* (July 31). Mr. Cutter thinks that a general uniform illumination of mild intensity, like that of a dark cloudy day or of a clear night with a moon, is the theoretical condition which it is desirable to artificially reproduce. This condition may be secured most economically and effectively by the installation of incandescent lamps, but Mr. Cutter advises, in addition, the employment of arc lights in the business portions of a town, which, after the business places are closed, may with advantage be replaced by a moderate illumination of the same character as that in the residence districts. The more the subject is studied by experts, the greater seems to be the appreciation of the advantages of the incandescent lamp for municipal lighting.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting

68. Notes on the Reconstruction of a Small Central Station Plant. Consolidation of three different plants, and change from steam to water power. Franklin L. Pope (Paper read before the A. I. E. E., Niagara Falls, June, 1895). Elec Rev–July 10. 7500 w.

181. The Time System of the Toronto Electric Light Company. Ill. (Describes and illustrates an apparatus and method whereby time indications may be accurately transmitted from a master clock in a central station). Can Elec News–July. 1700 w.

*202. Electric Lighting in the Far East.—An Alternating Station at Hong-Kong. Ill. (Descriptive). Elec Plant–July. 1300 w.

263. Lighting Mills with the Inverted Arc Lamp. From letter by D. L. Goff (Desricbes plant at Pawtucket, R. I. Economics). Ir Age–July 18. 1800 w

*291. Arrangement of an Electric Lighting Plant. Ill. Francis B. Crocker. Elec-Pow–July. 1600 w.

*320 An Example of Interior Conduit Wiring. (Designed for Messrs. Heclas, Sons and Co. of Reading) Albion T. Snell. Elect'n–July 12. 1000 w.

495. The Use of the Alternating Current for Lighting Gedney's Channel, New York Harbor. Ill. (Descriptive). Elec Eng–July 31. 800 w.

571. Economics in Small Central Stations. W. M. Stine (Less intelligence in the installation and operation of small plants. Arguments supporting this conclusion). W Elec–Aug. 3. 1100 w.

*607. Tests of Glow-Lamps. W. E. Ayrton

We supply copies of these articles. See introductory.

and E. A. Medley (Physical experiments). Ind & Ir–July 26. Serial. 1st part. 4000 w.

Power.

51. Electric Power in Factories and Mills. F. B. Crocker, V. M. Benedikt and A. F. Ormsbee (A paper read at the meeting of Am. Inst. of Elec. Eng., Niagara Falls, June 26, 1895). Elec–July 3. Serial. 1st part. 2500 w.

66. Compounding Dynamos for Armature Reaction. Ill. Elihu Thomson (Read before A. I. E. E., Niagara Falls, June, 1895.) Elec Rev–July 10. 2600 w.

108. Electric Locomotives on the Baltimore and Ohio Railroad. Ill. (Descriptive). W Elec–July 13. 3200 w.

*152. Early History of Electric Traction. I. William Chubb (The first electric locomotive is attributed to Thomas Davenport, Brandon, Vt., 1835). Prac Eng–July 5. 3000 w.

*153. Test of a Field's Combined Steam and Hot Air Engine. Andrew Jamieson, with editorial (Account of results of a test, wherein from a single cylinder, non condensing engine, I. H. P. per hour was obtained with a consumption of 18.6 lbs. of water). Prac Eng–July 5. 1500 w.

*203. Action of a Single Phase Synchronous Motor. Ill. Frederick Bedell and Harris J. Ryan (A study of the synchronous motor with particular reference to phase relations of the different variable quantities in any alternate current problem). Elec Plant–July. Serial. 1st part. 2400 w.

*204. Two-Phase Plant at the Pantin Works of M M. Weyher et Richemond. Ill. (Descriptive). Elect'n–July 5. 1100 w.

*205. Hysteresis, Frictional and Eddy-Current Losses in Continuous-Current Dynamos. George Adams (Describes Mr. Gisbert Kapp's graphic method of determination). Elect'n–July 5. 600 w.

*212. The I. E. S. Storage Battery for Lighting and Traction. Anthony G. New (Existing forms of accumulator plates and description of the I. E. S.). Elec Rev, Lond–July 5. 1600 w.

275. The Burton Liquid Electric Forge. Ill. W. W. Ker. (Descriptive). Elec Eng–July 17. 800 w.

277. Electric Freight Haulage. Editorial (A prediction that the trolley is about to cut deeply into the freight traffic of steam railways). Elec Eng–July 17. 700 w.

280. An Electric Traveling Crane for Carrying Baggage. Ill. (Descriptive of plant at Victoria Station, Manchester, England). Elec Rev–July 13. 250 w.

*294. The Utilization of Water Power in Connection with Electric Power Plant. Ill. Charles Simon Herzig. Elec Pow–July. 5500 w.

*328. Some Practical Hints in Dynamo Design. Gilbert Wilkes (From the Bulletin of the University of Wisconsin). Elec Eng, Lond–July 12. 5000 w.

344. Electric Welding for Repairs. Editorial (Convenience ; possibilities). Ry Rev–July 20. 800 w.

373. Canadian Water Power Schemes at Niagara, Montreal and Toronto. Ill. Elec Eng–July 24. 1200 w.

382. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton in Cassier's Mag. Sci Am Sup–July 27. 1000 w.

383. Long Distance Electric Power Transmission (Sacramento. Distance, 24 miles). Am Mach–July 25. 150 w.

399. Multiple Current Dynamos. Rankin Kennedy (Description of his own design). Elec–July 24. 1100 w.

400. Electric Traction by Accumulators. J. Sarcia. From "The Bulletin de la Société Internationale des Electriciens." Elec–July 24. 1800 w.

431. Economy of Conductors Used in Transmission of Current for Electric Railways (A summary of address by Edward P. Burch. Feeder Plan in service in Minneapolis and St. Paul. Called a jumper system. Its advantages). Elec Ry Gaz–July 27. 1800 w.

*465. Electrical Transmission of Power, with Special Reference to Mining Operations. H. T. Haws (Transmission over distances measured by the mile). Elect'n–July 19. 4000 w.

474. Distinguished Scientists in Acrid Discussion (Professors Rowland and Forbes write about the Niagara Question). Elec Rev–July 31. 2000 w.

475. Central Station Economics (Read before the Northwestern Elec Asso., Chicago, by J. S. Stephens). Elec Rev–July 31, 2000 w.

511. The Chicago Metropolitan West Side Electric Elevated R. R. Station. Ill. (Descriptive). Power–Aug. 1000 w.

512. Dynamos. Ill. First Aid to the Injured. Arthur M. Lozier (For the benefit of engineers who have in their charge either dynamos or motors). Power–Aug. Serial. 1st part. 2500 w.

†538. Electrical Construction on the Mount Holly Branch of the Pennsylvania Railroad. Ill. (Plant ; installation.) St Ry Jour–Aug. 1300 w.

†539. The Electric Conduit of the Metropolitan Railroad (Washington, D. C.) and the Reasons for Its Adoption. Ill. A. N. Connet (Sections of conduit ; insulation ; drainage). St Ry Jour–Aug. 1400 w.

†540. Electric Conduit for the Third Avenue Railway Company, New York. Ill. (Sections ; joints ; trolleys ; hand holes). St Ry Jour–Aug. 800 w.

†546. Test of an Electric Railway. Ill. A. Langstaff Johnston (Ammeter and voltmeter tests on grades and curves). Jour Fr Inst–Aug. 1000 w.

570. Electric Power (Record of some tests of machine tools). Bos Jour Com–Aug. 3. 1700 w.

*593. On the Investigation and Design of Alternate Current Dynamos. H. Behn-Eschemburg (A convenient method which furnishes direct values, and which permits of the comparison and discussion of alternators). Elect'n–July 26. 2000 w.

*628. Producer Gas Motors and Electrical Power Transmission (A remarkable application of electrical driving of machinery in the chemical manure works of M. Paul Linet, at Aubervilliers). Elec Rev, Lond–July 26. 1800 w.

629. The Belt as Applied to Electrical Apparatus. A. W. Foster (The article is confined to belts used with electrical machinery, but many of the facts mentioned are applicable to all belting wherever used). Elec Ind–Aug. 900 w.

645. A Ninety-six Ton Electric Locomotive. Ill. (The engine of the Baltimore & Ohio R. R.). Sci Am–Aug. 10. 1400 w.

Telephony and Telegraphy.

50. Independent Telephone Men Combine (The Telephone Protective Association formally organized). Elec–July 3. 900 w.

276. The Longest Telegraph Circuit in the World (In Australia; length 7246 miles). Elec Eng–July 17. 300 w.

279. Marshall Duplex Telephone System. Ill. (Descriptive). Elec Eng–July 17. 400 w.

281. Setting Type by Sound (An interesting experiment with the telegraph and the linotype. Reports can be taken from the wire and put into type by the receiving operator with great ease, speed and satisfaction). Elec Rev–July 17. 600 w.

282. The Parliamentary Telephone Inquiry in England. With Editorial (A resumé of evidence given before the committee). Elec Rev–July 17. 2500 w.

284. The Callender Automatic Telephone Exchange System. Ill. (Descriptive). Elec Rev–July 17. 350 w.

288. The Invention of the Electromagnetic Telegraph. Ill. (Facts bearing on the credit due respectively to Joseph Henry, S. F. B. Morse and Alfred Vail. Articles by Francis W. Jones, Franklin L. Pope, J. J. Fahie, Postrath Petsch, and A. M. Tanner). Elec Wld–July 20. Serial. 1st part. 3700 w.

290. Neglected Evidence in the Berliner Case. E. F. Frost (Concludes that the Berliner patent of 1891 was unwarrantably issued). Elec Wld–July 20. 3500 w.

*314. An Electric Telegraph in the Middle of Last Century. Ill. Charles R. Gibson (Historical and descriptive). Elec, Lond–July 12. 1400 w.

315. Storage Batteries for Telegraph Work. Maurice Barnett (Economical substitute. Will displace gravity cells where a changing current is available). W Elec–July 20. 2000 w.

374. Repairing Underground Telegraph Cables in West Africa. Ill. (A unique engineering experience). Elec Eng–July 24. 1800 w.

†567. The Telegraph in England. Walter Clark (Consideration of facts published in the official report of the government telegraph in England). Arena–Aug. 1500 w.

Miscellany.

53. Electricity at the Mining Exposition, Santiago, Chili. Ill. Harry Bindermann (Description of exhibits). Elec Eng–July 3. 1400 w.

60. Residual Charges of Condensers. A. S. Dunstan (Describes experiments with residual charges in condensers with mica dielectric). Elec Wld–July 6. 1600 w.

63. The Electrical Plant of the New State House of Massachusetts. Ill. W. L. Key (Details and descriptions). Elec Eng–July 10. 2400 w.

64. Some Features of Alternating Current Systems. Charles Proteus Steinmetz (Abstract of paper read before A. I. E. E., Niagara Falls, June, 1895). Elec Eng–July 10. 2000 w.

67. The Cause of Death in Electric Shock. A. M. Bleile (Experiments and data. Paper read at A. I. E. E., Niagara Falls, June, 1895). Elec Rev–July 10. 2200 w.

101. Advantages of the Dry Battery (Special fitness for open circuit work; little deterioration when not in use). Ir Age–July 11. 1200 w.

106. The Sensibility of Galvanometers. W. M. Stine (Attention called to the proper rating of astatic and non-astatic galvanometers). Elec Wld–July 13. 1600 w.

107. On Certain Effects Produced by "Distributed Capacity" in Wire Coils. A. S. Kimball (Experiments and remarks). Elec Wld–July 13. 2200 w.

*177. Some Uses of Curves in Electrical Practice. H. H. Simmons, with Editorial (Instruction in the use of curves in representation of physical facts, and analysis of curves so used. The writing and reading of curves). Elec Eng, Lond–July 5. Serial. 1st part. 1800 w.

*206. Arnoux-Chauvin Voltmeters and Ammeters. Ill. (Description of these new instruments). Elect'n–July 5. 900 w.

*207. Wave Form Synthesis. James Mark Barr (Describes the use of the electronometer or galvanometer and the tracing out of any Fourier function with a light spot on a moving photographic plate). Elect'n–July 5. 500 w.

*209. Experiments on the Relation of Hysteresis to Temperature. Frank A. Laws and Henry E. Warren (An account of some experiments to determine the effect of temperatures much above the normal on the dissipation of energy by hysteresis in a specimen of steel). Elec Rev, Lond–July 5. Serial. 1st part. 1200 w.

*210. The Electrical Standardizing Testing and Training Institution. Ill. (Descriptive of methods and apparatus used in this institution). Elec Rev, Lond–July 5. 1000 w.

283. Location of Grounds in Armatures, Fields, etc. Ill. Clarence E. Gifford. Read before Am. Inst. of Elec. Eng. at Niagara Falls (Descriptive of methods devised by the author). Elec Rev–July 17. 2500 w.

286. Long Distance Transmission at Ten Thousand Volts. The Pomona Plant. George Herbert Winslow. Read before the Am. Inst.

of Elec. Eng. at Niagara Falls (Descriptive of the plant of the San Antonio Light and Power Co. at Pomona, Cal). Elec Rev-July 17. Serial. 1st part. 4000 w.

289. Underground Wires in Boston. Ill. J. E. Talbot (Nature and extent of the undertaking). Elec Wld-July 20. 3300 w.

*293. Technical Instruments for Measuring Electrical Current Strength, Electrical Pressure and Electric Power. Ill. Alfred E. Wiener (A treatise for practical rather than scientific readers). Elec Pow-July. Serial. 1st part. 3000 w.

*322. Thermo-Electric Powers of Metals and Alloys Between the Temperatures of the Boiling-Point of Water and the Boiling-Point of Liquid Air. James Dewar and J. A. Fleming (Abstract of a communication made to the Phil. Mag. of July). Ill. Elect'n-July 12. 4500 w.

*323. Armature Cross Turns in Continuous Current Dynamos and Their Effects. Ill. George Adams. Elec Rev, Lond-July 12. Serial. 1st part. 500 w.

*327. On a Method of Determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold and Platinum. Ill. James H. Gray (Method suggested by Lord Kelvin. Advantages claimed: (1) It is simpler. (2) Test can be made in two or three hours. (3) Only a few grammes of the metal are necessary). Elec Eng, Lond-July 12. Serial. 1st part. 2700 w.

339. Economical Design of Electric Light and Power Plants. George W. Blodgett (Methods suggested and discussed). R R Gaz-July 19. 1600 w.

†369. Discussion on paper by H. Ward Leonard—"Notes on Recent Electrical Engineering Development in France and England." Trans Am Inst Elec Eng-May. 2100 w.

†370. Discussion of paper by Harris J. Ryan and Milton E. Thompson—"A Method for Preventing Armature Reaction." Trans Am Inst Elec Eng-May. 2600 w.

†371. Discussion on paper by A. E. Kennelly—"Resonance in Alternating Current Lines." Trans Am Inst Elec Eng-May. 5000 w.

†372. Discussion of paper by Prof. Anthony—"Underwriters' Rules." Trans Am Inst Elec Eng-May. 18900 w.

375. The Inductance of the Di-electric. John S. Stone (Explanatory remarks on meaning of the term). Elec Rev-July 24. 1300 w.

401. Indirect Electrolysis. E. Andreoli. Translated from "Le Génie Civil" (Explanation). Elec-July 24. 1500 w.

416. General Electric and Its Schenectady Plant (Advisability of removing the plant). Elec Wld-July 27. 1200 w.

417. The Monocyclic System. Ill. (Explanation of the system by C. P. Steinmetz). Elec Wld-July 27. 500 w.

*461. The Valency of Mercury and Copper in Certain Electrolytes (Extracts of special interest from paper by Dr. Werner Bolton, published in the Zeitschrift für Electrochemie). Elect'n July 19. 1400 w.

*462. Observations on the Holtz Theory of Influence Machines with Oppositely Rotating Discs. James Wimshurst. Elect'n-July 19. 2000 w.

*463. Theory of the Influence Machine with Oppositely Rotating Discs. Ill. W. Holtz (Complete account of theory and of various forms which may be given to the machine). Elect'n-July 19. 2400 w.

*464. On the Theory of the Wimshurst Machine. Ill. V. Schaffers. From the Annales de Chimie et de Physique. Elect'n-July 19. 2500 w.

*491. The Design of Transformers. George Adams (Transformers having a closed magnetic circuit, and to be connected in parallel on constant potential mains). Elec Rev, Lond-July 19. Serial. 1st part. 1200 w.

*492. Electrical Engineering Education. Ill. William A. Anthony (The facilities offered at Cornell Univ. with general remarks). Elec Pow-Aug. 2500 w.

*493. Electro-Deposition of Brass. Frank Sutton (The object of the article is more on a theoretical basis than a practical one, but really includes both). Elec Pow-Aug. 2000 w.

*494. The Counter Electro-motive Force in the Electric Arc. W. H. Freedman (Experimental investigations). Elec Pow-Aug. 2400 w.

496. English Internationalism. E. Hospitalier in L'Industrie Electrique (The services it can render to the c. use of uniformity of symbols, notation and physical units). Elec Wld-Aug. 3. 1400 w.

†518. Electric Heating J. Chester Wilson (Various applications; conveniences; discussion). Pro Eng Club of Phila-July. 4200 w.

†527. On the Velocity of Electric Waves. Ill. John Trowbridge and William Duane (Experimental results). Am Jour of Sci-Aug. 2000 w.

*588. The Factory Testing of Vulcanized India-Rubber Covered Cables and Wires. Ill. J. Warren. Elec, Lond-July 19. Serial. 1st part. 1000 w.

*594. Shipboard Galvanometers. J. Rymer-Jones (Tests of the Weatherall & Clark damping device as applied to the Thomson marine galvanometer, and the Sullivan "Universal"). Elect'n-July 26. 1100 w.

*595. New Method of Measuring Electric Capacities, Based on the Sensitiveness of the Skin. H. Bordier. Elec Eng, Lond-July 26. 800 w.

623. The Relations between Pressure, Electrical Resistance and Friction in Brush Contact. Ill. E. V. Cox and H. W. Buck (Investigation undertaken with the object of furnishing some accurate data on the subject). Elec Eng-Aug. 7. 1200 w.

624. My Experience with Interior Work. A. E. Dobbs (Wiring). Elec Eng-Aug. 7. 2000 w.

627. Electrical Interference. Arthur Vaughn Abbott (Read before the Northwestern Electrical Association, Chicago). Elec Rev-Aug. 7. Serial. 1st part. 900 w.

We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

The Twentieth Century.

IN an address delivered before the graduating class of the Yale Law School Justice Henry B. Brown, of the United States supreme court (*Forum*, August), rapidly reviews the enormous industrial and commercial changes that have marked the present century, and makes a forecast of what the twentieth century is likely to bring about. The primary effects of the numerous and astonishing inventions to which the century has given birth, important as they are, even beyond estimation, he regards as of much less economic importance than the "secondary effects which have become apparent within the past 30 years, and which threaten, not only to affect the political future of every State, but to revolutionize the entire productive industry of the world. It is a change which began silently, has progressed furtively, but relentlessly, and is yet only at the threshold of its tremendous possibilities. So unforeseen was it that it may be said to have stolen upon us like a thief in the night. It may be summed up in the single word 'consolidation,'—consolidation in politics, in business, in society. This influence is everywhere the same: the centralization of power in the hands of a few; the unification of people of kindred race and similar language; and, in this country, a vast accession to the power of the federal government. Wise men may differ as to whether the liberties of the people can better be preserved in large States or in small ones. History doubtless favors the latter, but the historical republics had neither steam or electricity, or the general diffusion of education and intelligence they have brought in their train. In producing the evil—if it be an evil—they have also furnished the antidote. The nineteenth century has given birth to large States, but at the same time has curtailed the privileges of the great, has expanded the area of freedom, and entrenched the people in their natural rights. But these speculations are of little value. The large States are upon us and overshadow us. They have come to stay, and, for better or for worse, the world must adapt itself to their conditions." The same influence pervading industry has "revolutionized the whole system of production. The results are large enterprises, only rendered possible by combinations of capital; great corporations, monopolizing the production of all the comforts and many of the necessaries of life; immense farms and pastures, flooding the markets of Europe with cheap meats and grain, curtailing the rents of the landlords, and depressing the value of our lands; the crushing out of small producers, and the centralizing of production where labor and material can be obtained the cheapest." That the organizers of the great enterprises which are swallowing up the smaller appropriate to themselves "an apparently disproportionate share of the profit" is ascribed to "a universal law that the man who develops extraordinary capacity in any direction receives an extraordinary reward."

Thus portraying the present tendency to consolidation, Justice Brown thinks "we may safely assume that it will be prolonged into the twentieth century; . . . that the great powers of Europe, which have already parcelled out among themselves almost the entire continent of Africa, will look for new fields of conquest in the extreme east: that the process of absorption will go on with the usual indifference to the wishes of the native populations; and that another hundred years may see the entire eastern hemisphere under their control. It will be your duty to see that their rapacity does not extend to the western hemisphere. The lust of conquest, like that of acquisition, knows no bounds."

The great changes that will make the twentieth century remarkable are likely to be social rather than either political or legal. Labor and capital are regarded as arrayed against each other in strife. On

the one hand the gigantic trusts, on the other the labor combinations, which combinations of capitalists have, by example, taught the lesson of organization. "The reconciliation of this strife, if reconciliation be possible, is the great social problem that confronts us." Individualism for 4000 years is regarded as having progressed with civilization; in fact, the history of the one is that of the other also. Hence "the destruction of private property cannot be the solution sought." Judge Brown asserts that under "our present social system, with all its faults, the civilized world is constantly growing richer, freer, more prosperous than ever before,—the richer less ostentatious in the display of their wealth; the poorer better housed, better clad, and better fed. Certainly the burden of proof is upon those who claim that this civilization is a failure. Nothing can demonstrate the soundness of their principles so well as a practical experiment in socialism upon a large scale. If a successful experiment on that scale could be offered to the world, they might have some title to claim that civilization should be organized upon that model."

"While it is entirely true that the business methods of the past 30 years have tended to increase enormously the fortunes of a few, and thus to widen the gulf between the very rich and the very poor, it is wholly untrue that the poor as a class are either absolutely or relatively poorer than before. Indeed the number of small, but comfortable, houses in every part of the country, as well as the reports of savings-banks and building and insurance associations, prove incontestably that the poor have shared in the prosperity of the rich, and that the average standard of comfort was never higher than at present. Indeed, the average working-man of today lives better and possesses more of the comforts of life than the average noble of 600 years ago. The sins of wealth, though many and grievous, have not generally been aimed directly at the oppression of the poor."

The "gradual enlargement of the functions of government" and "the ultimate control of natural monopolies" is the most probable result to which Justice Brown looks forward. As coming from a chief justice of the United States, this address will seem singularly lacking in originality of expression, to say nothing of originality in thought. It may be said, however, that so much has been thought, said, and written as to probable results of present tendencies that not much of originality or of added force to old arguments restated was to be expected, even from this high source. Corruption and bribery, which the speaker was unwilling to attribute solely to corporations, are spoken of as "a great present danger." A "government by the better classes" is suggested as a possible remedy for this; but a government by the whole people was the original American scheme, from which government by an aristocracy would be a wide departure. It is too late to dream of any such system. Trusts may be carried to a revolutionary extent, and are already a just subject of public alarm. On the whole, the speaker does not regard "the outlook for a permanent peace between capital and labor" as "an encouraging one," and he concludes his address by saying that "it has been given to the nineteenth century to teach the world how a great republic can be founded upon principles of justice and equality; it will be the duty of the twentieth to show how it can be preserved against the insidious encroachments of wealth as well as the assaults of the mob."

Balance of Occupations.

IN the *American Magazine of Civics* Mr. R. C. Barnett endeavors to trace up from primitive society the course of evolution of occupations, diversity in which is attributed to the want of homogeneity in human society, as well as diversity of wants, which latter, in fact, is a result of non-homogeneity. "The incident force of want acting upon the slightly heterogeneous group" (primitive association) will have the tendency toward differentiation of acts. At the same time that differentiation occurs, there will be a tendency toward integration of the members of the tribe into groups,—for example, warriors, hunters, fishers, etc. This differentiation and concomitant inte-

gration, this process of evolution, will continue till equilibrium is reached. To answer the question: "what must be the correlation of wants and acts?" he imagines an ideal typical society, and the changes that would attend its development, and thus attempts to deduce laws for its growth. Thus he concludes that, when the condition of economic equilibrium is reached, the "relation that would then exist among men would be that of equality of opportunity,—that is, each and every member of the social organism would have an equal opportunity to work to his full capacity, and the relation of occupations would be so nicely adjusted that each would receive the highest possible wages. This would not be the kind of equality that statutes grant, but rather the kind that nature seeks to maintain. When this state of equilibrium is reached, the path of least resistance will have been traversed. There will be no inducement for a man to change his occupation. He will get the most and the best that his individual efficiency permits.

"But what are the conditions of equilibrium? What relation will then exist among the occupations? The ultimate recompense of any man in any occupation is a portion of the primitive output. Then, for a given number of persons, the greater this primitive output, the greater will be each one's portion. The great desideratum, therefore, is that the primitive output be the maximum." Mr. Barnett illustrates this by an imagined typical society of farmers. "The first derivative occupation would be the making of farming implements," and there will be a series of derivative occupations. He finds between the state wherein the farmers, lacking tools, would produce a relatively small output, and a state wherein the tool-makers would make more tools than the farmers could use, a point where the tool-makers could make just the right quantity and quality of tools. That would enable the farmers "to use the tools to their utmost capacity. This maximum being reached, the individual's shares would be the maximum also. This would be the best that he could do. There would be no inducement for any one to make a change, for in doing so the balance of occupations would be destroyed and the output would become smaller.

"Now, the numerical relation between the number of men engaged in any primitive occupation, and the number of men engaged in its first derivative occupation, cannot be given here, for want of sufficient statistics; but the general rule may be stated thus: (*a*) There is one, and only one, certain ratio which permits of the maximum output being realized. (*b*) The maximum primitive output and balance of occupations (equilibrium) are concomitant effects of the same cause, and are realized only when the certain ratio is attained."

No man, according to this theory, would leave the primitive to engage in a derivative occupation, unless by this he could increase "the output with respect to the amount and character of the work," and thus gain a larger share of total output in the derivative occupation.

The general tendency of society is regarded as toward the ideal equilibrium herein delineated, and the author thus reaches a cause assigned for "the economic evils which confront us to-day. . . . This cause is the unbalanced condition of occupations. There is a strong tendency nowadays for people to leave the primitive and enter the derivative occupations. As we have previously seen, this tends to lessen the primitive output; but at the same time this tendency is counterbalanced up to a certain degree by an increased efficiency. Beyond this point there is an actual decrease in the primitive output. It is the primitive output that is consumed in satisfying wants; and the man who produces this primitive output will have the first chance to use it. The derivative output will not satisfy directly any wants. It must be exchanged for the primitive. If there is a scarcity of the primitive and an excess of the derivative output, all who are in the derivative occupation will not have a chance to exchange their output for a portion of the primitive. They will suffer more than those in the primitive, who have a better opportunity to satisfy their wants. Therefore it is better for the social organism that there should be a

greater tendency toward the primitive occupations than toward the derivative. In other words, there would not be such dire suffering if there were an excess of farmers as there would be if there were an excess of mechanics. Therefore, the tendency of legislation should be, for the present at least, to increase the desirability of farming rather than otherwise."

Of course this all leads up to the inevitable "single tax" theory, and the conclusions are that encouragement for a return to the primitive occupation of farming should be sought, and that this encouragement will result from a "change in our system of land tenure that would permit of any one going to the best available unused land and farming it."

Protection and Farmers.

UNDER this title the *Social Economist* for August alleges that "the doctrine of protection as a national policy is still very imperfectly understood." It cites the attitude of the free-silver advocates as proof of the allegation. "They insist that silver is entitled to protection as much as is woollen cloth, silk, pottery, or any other American product. To them the adequate protection of silver means that the government shall buy all the silver they produce at $1.29 an ounce, whether it needs it or not, solely to keep the price of silver up to that figure, insuring a profit of from 40 to 50 per cent. If this kind and degree of protection is not conceded by either the Republican or Democratic parties, the free-silverites threaten to organize a free-silver party." The scheme, which originated in California, and which aims to secure from the government a bounty for all agricultural exports equal to the cost of transportation from American ports to Liverpool, is cited as further proof that the doctrine of protection is widely misunderstood. The originators of the movement (said to have received the approval of a considerable following) argue "that farmers have to sell their products at free-trade prices abroad and less than free-trade prices at home by the amount of transportation," while they are "compelled to purchase the articles they consume, but do not produce, at protection prices, due to the discrimination of our tariff laws in favor of American manufacturers." They declare that they will no longer submit to this alleged "double injustice," and that they will offer themselves to the Democrats or Populists, or organize an independent party to right the wrong. The article under review attempts to show that the view on which this action is based is erroneous.

"The claim that the price of farm products, such as cotton, corn, and wheat, is fixed at Liverpool is one of the economic fallacies that free-trade doctrinaires have dinned into the ears of farmers for the purpose of making them believe that they got no benefit from protection. It is not, and never was, true." This is followed with an argument to show that this scheme is not protection, but paternalism pure and simple, and that it "is exactly like asking the government to give every farmer a check on the United States treasury once a year equal to what it would cost to send his entire crop to Liverpool, even though he did not send a bushel." As to the lowering of prices, it is said that the "prices of manufactured products, taken as a whole, have been lowered nearly ten-fold as compared with agricultural products. In fact, the price of many agricultural products has not been lowered at all; beef, mutton, eggs, butter, etc., are higher now than they were three-quarters of a century ago, while nearly all manufactured products have been reduced from 20 to 80 per cent."

"The plea that farmers have been injured by the development of manufacturing industries is one of the worst heresies of our time, and those who advocate it are the real enemies of the farmers. In all the schemes of Populism nothing has hitherto been proposed which savors more strongly of economic insanity than to give a bounty on agricultural exports. It is contrary to every principle of economic and national development. It is the advocacy of such paternal schemes as this that brings protection into disrepute. It is time that a sharp and broad distinction was drawn between protection and paternalism,—dis-

tinction so clear that absurd projects like asking the government to purchase the product of one industry or pay the freight of others merely to insure profits could not be publicly announced without relegating its author to economic oblivion.

"Protection is not the doctrine of government ownership, either of production or products, but of protecting the opportunities of Americans to produce for and sell their products in the American market. For the government to assume responsibility for either producing or purchasing products is purely paternalism,—not protection at all. If this were distinctly understood, neither silver producers nor producers of any other commodities would ever think of demanding as the price of political allegiance that the government should become the 'unlimited' purchaser of their wares at a fixed price, equivalent to nearly double the cost of its production."

Pictorial Financial Arguments.

THE way in which the pencil of the artist and the crayon of the lecturer may be used in argument of a specious, but misleading, kind in the discussion of financial questions is the burden of a readable article in *Rhodes's Journal of Banking* for July. One of these drawings on a blackboard is a pair of scales. In one pan are bags of gold; in the other, wheat and cotton. "An individual labeled 'Financial Operator' presses down the pan containing wheat and cotton, and lifts up the pan containing gold. . . . At his side is a huge sack filled with small bags of so-called hoarded gold." Of course the idea intended to be conveyed is the disturbance and depression of prices by rich financiers for their own benefit.

Of another picture—a cube said to represent all the gold there is in the world—it is remarked that "why this should be anything pertinent to the argument does not appear. The deviser of the design says it shows that gold is too scarce a metal to furnish all the money required, and the fly gobblers take his word for it. . . . The whole population of the world can stand in a space 12 miles square, allowing every man, woman, and child 2 sq. ft. of space. But this does not prove that there ought to be more or less people, or that the world is not well populated."

"Another design represents Columbus discovering America, and its counterpart represents the statue of Columbus at the World's Fair in Chicago in 1893. The idea is that in 1492 the live Columbus found a lot of gold and silver bullion in the new continent, and that his statue in 1893 overlooked a scene of commercial ruin caused by the refusal of the world to use as money the silver he discovered. Probably Columbus, if he could have returned in person and visited America in 1893, would have been more struck with the wonderful wealth of the United States than with its poverty during a temporary depression of business.

"The next design on the blackboard is a colossal figure 'one.' This illustrates the monetary unit. Probably the public does not require this illustration to understand that a unit means one.

"One design shows two little men with heads in the shape of bags of money, walking arm in arm to a door labeled 'United States Mint.' One is labeled 'gold,' the other 'silver.' The next represents gold inside the door grinning at silver, who now lies on his back dead, stabbed with a huge quill pen. This represents the so-called 'crime of 1873.'

"Of two other designs one represents the happy condition of labor in 1872 under alleged bimetallism, and the other the distressed condition of labor in 1894 under monometallism. As this design would prove just as much if one were labeled prosperous times under bimetallism in 1857, it is of universal application, and proves nothing except to those disposed to take the designer's word for it all.

"The arguments of the monometallist are portrayed by a figure of a man who, with fists clinched, is shouting 'frauds, blatherskites, thieves, swindlers, repudiators, charlatans, lunatics.' This might as well be labeled 'silver advocates,' and be just as true to facts.

"Another design represents two hands pulling two buttons by cords attached to a

level beam. If either cord is relaxed, the button attached will drop down. These hands and cords are meant to show the effect of demand on price. If the demand for silver, or gold, or iron, or lead, or copper were the same, then the value of equal quantities of each of these metals would be the same. No account is taken of the supply. According to this illustration, a sufficient pull from the hand above would bring up an ounce of mud to an equality with an ounce of gold."

A quotation from Rabelais fitly concludes the article, and casts well-deserved ridicule on all this kind of claptrap.

Commercial Education in Europe.

AN abstract of a paper read by Mr. William Layton before the Society of Arts (*Engineering News*, July 4) makes a claim for superiority of the continental as compared with the English system of commercial training. In Mr. Layton's view the first-named attains to the rank of "thorough education," while all he can say for the latter is that it is "mere instruction." Belgium, leading the van, has in the "Institut Superieur de Commerce," established in 1853, furnished a model for similar institutions in France, Switzerland, Germany, and even Japan.

"The first difficulty encountered was the general belief that a small amount of education was sufficient for a man destined to be a trader, and pupils were scarce. But the government saw fit to share the expense with the corporation of Antwerp, and the school was started with 51 students of commerce. This number steadily increased, until in 1892 the attendance reached 945, of which 406 were foreigners; on that date also 249 graduates of the school occupied the position of chiefs in the most important mercantile firms of Belgium; 218 were bank managers or commission merchants; and the consular positions of the country were filled with them. It is evident that the Institut has well served the purpose for which it was founded. Students are divided into two classes,—the 'regular' and the 'free.' The first attend all lectures in a prescribed course, with a view of obtaining a diploma at the end of 2 years; the second class only follow lectures deemed best fitted to advance the student in a selected career. The entrance examination requires a competent knowledge of single and double-entry bookkeeping, geography, history, natural philosophy, chemistry, geometry, arithmetic and algebra, commercial law, and the elements of political economy. In fact, the conditions of entrance are about the same as those demanded for matriculation at the English universities. The 'free' student need not pass this examination. The course of instruction is practical as well as theoretical. The transactions of a large commercial house and the operations of a counting-house are minutely simulated, and the student is obliged to carry on the 'office' correspondence in French, German, and English. He must also be competent to correspond in one other foreign tongue, generally Spanish, Italian, or Dutch. The principles of political economy, of international commercial law, and customs regulations are inculcated, and the student is made to especially study foreign markets in reports sent in periodically by Belgian residents abroad.

"A well-furnished museum and a proper staff make the student well acquainted with the vegetable, mineral, and animal products in which he may be some time called upon to trade; and this department includes as well the geography of foreign countries and their commercial condition, as studied from carefully-compiled data, the relative value of raw materials from different sources of supply, and the latest consular reports from all countries."

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*1. The Business Situation in Review. Newton Sharp (The outlook for autumn trade). Eng Mag–Sept. 3600 w.

*4. Labor Legislation in the United States. George Kirby Holmes (The multiplicity of needless laws.) Eng Mag–Sept. 3000 w.

12. Commercial Education in Europe (Abstract of paper read before the Society of Arts by

We supply copies of these articles. See introductory.

William Layton—Best methods of fitting young men for trade and manufacturing). Eng News-July 4. 1200 w.

45. The Present Status of the Trade School Movement. C. R. Richards. Ry Rev-July 6. 2400 w.

*62. The Financial Situation (Economically considered). Bank Mag, Lond-July. 3500 w.

104. Railroad and Industrial Development Essential to General Prosperity) Editorial. Home market for agricultural, mining and forest products). Mfrs Rec-July 12. 1000 w.

†144. Liquor, Land and Labor. X. Y. (Local option—sale of liquor—in England, and a criticism of individualism as opposed to socialism). Fort Rev-July. 3500 w.

†194. The Money Unit of the United States. E. O. Leech (A critique of The Free Silver Argument. W. A. Harvey in the Forum for June). Rhodes' Jour of Bank-July. 2500 w.

†195. Competition from Silver Standard Countries. Worthington C. Ford (Effect of variation in price of silver upon the productive and exporting capacity of silver-using countries). Rhodes' Jour of Bank-July. 3500 w.

†196. Pictorial Financial Arguments (A critique upon the pictorial or graphic method in dealing with financial statistics and discussion of the money question). Rhodes' Jour of Bank-July. 2200 w.

†197. World's Production of Gold and Silver (Bureau of the Mint Estimate for the calendar year, 1894). Rhodes' Jour of Bank-July. 500 w.

*389. Belgian Tariff Modifications. Bd of Tr Jour-July. 3500 w.

*390. Tariff Changes and Customs Regulations. Russia. The New Harbor at Theodosia (Crimea). Norway. North Sea and Baltic Canal. France, Spain, United States, Colombia, Peru, Tahiti, Bombay, Malta, Canada, South Australia, Victoria.—Bd of Tr Jour-July. 5000 w.

*391. The Twentieth Century. Henry B. Brown (Summary of changes of the past century. Changes of the next promise to be social rather than legal or political. Perils of municipal misgovernment, corporate greed and tyranny of labor). Forum-Aug. 7000 w.

*393. Is an Income-Tax Socialistic? W. H. Mallock. Forum-Aug. 12500 w.

*395. The Deep-Waterways Problem. E. V. Smalley (The demand of the west for an open waterway to the sea). Forum-Aug. 2800 w.

444. Gold and Silver.—Their Production, Uses and Logical Ratio. Richard P. Rothwell (Statistics and conclusions). Eng & Min Jour-July 27. Serial. 1st part. 2600 w.

*448. Protection and Farmers (False economics; bad public policy). Soc Ec-Aug. 2500 w.

*449. The Cost Theory of Value (Criticism of article in "The American," Phila.) Soc Ec-Aug. 1800 w.

*450. The Vacuum in Our Currency System (An attempt to prove that there is not solidarity and community of interests between the Government, bankers, merchants and people, and concludes that the fate of silver in America waits for legal specie payments). Soc Ec-Aug. 2200 w.

*451. What Brought the Factory Acts? Wilbur F. Crafts (Cruelty and injustice to men, women and children. The problem of equal rights in production). Soc Ec-Aug. 1500 w.

454. Land Tenure in Tuscany. Janet Ross in Littell's Living Age (Equal division between owner and tiller of all crops gathered from the soil). La Planter & Sugar Mfr-July 27. 2000 w.

†458. Leo XIII and the Social Question. J A. Zahm (An exposition of the origin, character and history of the social question from the Roman Catholic point of view, and the gist of the Pope's teaching regarding it, as gathered from letters and encyclicals). N Am Rev-Aug. 6000 w.

†568. An Arbitration Treaty between Great Britain and the United States. George H. Emmott (The substance of an address delivered at Lake Mohonk on the question of influencing public opinion in favor of the settlement of international disputes by arbitration). Arena-Aug. 2200 w.

*573. Bimetalism and Currency. Joshua Douglass (What money is. Condition of affairs in the United States during past twenty-five years). Am Mag of Civ-Aug. 4800 w.

*574. A Plea for a Sound Currency and Banking System. Allen Ripley Foote. Am Mag of Civ-Aug. 4500 w.

*575. The Necessity of State Labor Tribunals. Norman T. Mason (The decisions of such a tribunal more likely to be just to both parties). Am Mag of Civ-Aug. 2400 w.

*577. Balance of Occupations. R. C. Barnett (An article purposing the investigation of the actions that minister to the wants of man, and their effects). Am Mag of Civ-Aug. 3500 w.

643. Elements of a Plan of Ship Protection W. W. Bates (Protective measures advocated are chiefly discriminating duties, bonding privileges, and export bounties). Sea-Aug 8. 4000 w.

*664. The Conduct of Business by Companies (Attention called to the report by the Board of Trade on the Companies Winding-up Act, which describes what has taken place recently in the way of the liquidation of such companies). Bank Mag, Lond-Aug. 2500 w.

*665. The Recovery from the Panic of 1893 in the United States. D. M. Frederiksen (Why it was slow. Why we may consider the revival assured. Causes affecting). Bank Mag, Lond-Aug. 5000 w.

†681. Rubber and Other "Industrials" (Editorial comparison of "industrials" in American and Foreign Stock Exchanges). Ind Rub Wld-Aug. 10. 1200 w.

†682. Wanted, a New Foreign Policy (Editorial on trade relations with countries on American soil). Ind Rub Wld-Aug. 10. 800 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

The Yacht as a Naval Auxiliary.

THE marvellous growth of yachting in the United States during the last 20 years is regarded by Hon. William McAdoo, assistant secretary of the United States navy, in the *North American Review* for August, as "one of the many signs of the turning of our people again to the sea, and the re-establishment of our merchant marine in the proud position it held in the days of the famous clipper ships."

There are, or were, at the beginning of the present year, "ninety regular organized yacht clubs in the United States," while "in all the remainder of the hemisphere there are but seven,—three in Canada, and one each in Nova Scotia, Cuba, Jamaica, and the Argentine Republic." Of the ninety clubs in the United States the distribution by States is as follows: "New York heads the list with thirty-two clubs; Massachusetts has nineteen; New Jersey, ten; Connecticut, seven; California and Rhode Island, three each; Maine, Pennsylvania, Maryland, and Florida, two each; North Carolina, South Carolina, Alabama, and Louisiana, one each; and there are ten clubs along the lake region on our northern boundary, two of which are included in the thirty-two credited above to New York. Of the clubs enumerated as to States, at least forty are located in New York harbor, Long Island sound, and their adjacent waters. The interior waterway communication along our coast line, so well illustrated in the recent trip of the torpedo boat Cushing, gives additional impetus to yachting through the enormous water course it is now possible to traverse in even the smallest class of yachts with perfect safety, and to the rivalry thus offered through visiting yachts from various sections of the coast." Mr. McAdoo thinks that both the yachts and the men interested in and engaged in yachting may be made of great use to the country; the men become especially well trained in yachting service, and the vessels, though not now such as could be of much use to the government, might be, "by mutual agreement between yacht owners and the government when the plans are under consideration, . . . constructed to answer the double purpose of yachts in time of peace and naval auxiliaries in time of war." Three classes of yachts are named as adapted for use as naval auxiliaries.

"1. The large, full-powered steam yachts, like the Atlanta, Corsair, Conqueror, Columbia, Electra, Eleanor, Margarita, May, Namouna, Oneida, Peerless, Sagamore, Sapphire, Utowana, and Valiant.

"2. The auxiliary type with moderate steam and sail power, as illustrated by the Intrepid and Wild Duck.

"3. The high-speed boats for sheltered waters and comparatively short runs, like the Now Then, Say When, Helvetia, Norwood, and a host of others."

There seems to have been some doubt in the mind of the author as to whether this scheme possesses the element of practicability. It appears to us highly impracticable. The primary reason for building yachts is that they give pleasure to their owners. They are in their nature pleasure boats. All except the larger ones are stinted for room, and an attempt to make them fit for use in auxiliary naval service would necessarily either curtail the room or necessitate larger vessels. As to the agreement between the owners and the government, Mr. McAdoo does not see clearly how it could be reached, but seems to have well-defined ideas as to what the government should demand on its part. "The government might furnish inspectors to superintend the building; provide all the supports, racks, bulkheads, fittings, and outfits of a military character; have the yachts regularly inspected as to hull fittings and machinery and the competence of the master and engineers; and, finally, enroll them in a naval reserve, with the right to fly a special flag and to uniform their officers and crew in conformity there-

with. In return the government should have the right to charter or purchase them in time of war, and, by special agreement, to use them for a few days each year for drill or training purposes at a time when the owners would need them least."

We are asked to take for granted that this would not spoil a yacht in any way for the purposes for which the owner built her,—an assumption which most people at all acquainted with yachts and their uses will regard as absurd. Moreover, in this scheme the government is not to offer anything to the owner "in the nature of a bonus." The owner is, therefore, provided he be patriotic enough, to submit himself to grave inconveniences and his yacht to government inspection, and to the increased weight of "racks, bulkheads, fittings, and outfits of a military character," for nothing except the gratification of his patriotic sentiments. We opine that he will prefer to build and use yachts as heretofore, and, when his patriotism becomes so imperious that he must gratify it, find some other way of giving it expression. Perhaps we may next hear of a scheme emanating from the war department to the effect that we shall use our country houses for the double purpose of a retreat in summer and as arsenals which could be used as military auxiliaries in war-time, and an agreement between owners and the government to have them built under the superintendence of government inspectors.

The Laws of Similitude as Affecting Naval Construction.

In an abstract from a memoir published in the *Bulletin de l'Association Technique Maritime, Engineering* (London, July 12) gives important data and formula. With reference to alteration of drawings of an engine made to a given scale, the author reaches the conclusion that, as regards stresses depending upon static forces (pressure of steam), the factors of safety remain the same, whatever be the scale. As to stresses due to weight of the engine and movement of the vessel in a seaway, the law of similitude does not hold. The rapidity and amplitude of movements of the vessel must be taken into account. "No engine of great power fitted in a light hull will work well, unless secured to the hull at several points. This is necessary, not only on account of the weakness of the base to which it is attached, but also because of the slightness of the connection between the upper parts of the engine and the bed-plate. The hull, in fact, contributes to the solidity of the engine. This arrangement would be inadmissible in very large vessels, on account of the excessive stresses which would be thrown upon the engine. The dimensions of engines of this type cannot, as a rule, be indefinitely augmented. The author has constructed engines working under these conditions, but in his latest torpedo-boats, although they are connected to the hull at several points, it is for a different purpose. The engines are more rigid than the hull, and, if the base to which they were secured were sufficiently strong, they would not require any further attachment. The following rules are applicable to them. As angles of rolling of 40° and 45° have been observed, it would seem advisable, in the case of vertical engines attached to the hull by the bed-plate only, to make them so secure that they could support themselves in a horizontal position. If this condition be fulfilled, the stress per unit of section is proportional to the linear dimensions. It follows that parts subjected to such special strains should increase more rapidly with increase of size than the scale would indicate, and therefore the weight of the engine will increase rather faster than the cube of the dimensions."

In order that the fall in pressure shall be independent of the scale to which the engine is drawn, the revolutions must be inversely proportional to the linear dimensions. Except that, as stated, parts exposed to special strains should increase more rapidly with increase of size than the scale would indicate, a drawing of an engine to work at a given steam pressure may be altered to any scale, without alteration of stress on a unit of section of any of the working parts, the friction of any of the rubbing parts, or the fall in pressure, provided the rule be observed that the revolutions be inversely proportioned to the

linear dimensions, as above set forth.

The power of the engine will, under the same conditions, "be proportional to the square of the linear dimensions, and the weight per horse power will be proportional to the linear dimensions"; that is to say, "that is true for the main engines, shafts, bed-plate, connecting rods, etc.," but "not for condensers and boilers."

The author declares that he has "frequently constructed engines of different sizes from the same plans by altering the dimensions to scale, thereby saving much time and labor. For example, the engines of the Russian torpedo-boats Revel and Sveaborg, constructed in 1885, were similar to those of the Balny, the scale being increased in the ratio of 1 to 1.9, and in 1891 the drawing of the first-class torpedo-boat engines of No. 147 type served for the construction of the twin-screw Lancier type, and for the steamer Augustin Normand, the scale being reduced to 0.9 in. in the first and to 0.81 in. in the second. Such progress has been made in the manufacture of large steel forgings and castings that the author would not hesitate to use the same drawings for the construction of much larger engines,—3000 or 4000 indicated horse-power, for example,—taking care to provide against special stresses due to the movements of ships at sea."

—	Proportional Values, the Number of Revolutions being	
	Independent of the linear dimensions of the engine.	A maximum such that ratio of inertia to static stresses is constant.
Number of revolutions n	$\frac{F}{\lambda^2}$	$\frac{1}{\lambda}$
		$\frac{1}{F^{\frac{1}{2}}}$
	$\frac{V^2 D^{\frac{2}{3}}}{\lambda^2}$	$\frac{1}{V^{\frac{1}{2}} D^{\frac{1}{3}}}$
Speed of vessel V	$\left(\frac{F}{D^{\frac{2}{3}}}\right)^{\frac{1}{2}}$	$\left(\frac{\lambda}{D^{\frac{1}{3}}}\right)^{\frac{3}{2}}$
	$\lambda\left(\frac{n}{D^{\frac{2}{3}}}\right)^{\frac{1}{2}}$	
Displacement ... ... D	$\left(\frac{F}{V^2}\right)^{\frac{3}{5}}$	$\left(\frac{\lambda}{V^{\frac{1}{2}}}\right)^3$
	$\left(\frac{n\lambda^3}{V^2}\right)^{\frac{3}{5}}$	
Indicated horse-power... F	$\frac{n\lambda^3}{V^3 D^{\frac{2}{3}}}$	λ^2
Linear dimensions of propelling machinery λ	$\left(\frac{F}{n}\right)^{\frac{1}{2}}$	$F^{\frac{1}{2}}$
	$\frac{V D^{\frac{2}{3}}}{n^{\frac{1}{3}}}$	$V^{\frac{1}{2}} D^{\frac{1}{3}}$
Weight of propelling machinery without condenser	$\frac{F}{n}$	$F^{\frac{1}{2}}$
	$\frac{V^2 D^{\frac{2}{3}}}{n}$	$V^{\frac{1}{2}} D$
Weight per horse-power of propelling machinery without condenser	$\frac{1}{n}$	λ
	$\frac{F}{n^2 \lambda^2}$	$V^{\frac{1}{2}} D^{\frac{1}{3}}$
Ratio of linear dimensions of engine to those of hull	$\frac{\lambda}{D^{\frac{1}{3}}}$	$V^{\frac{1}{2}}$
	$\left(\frac{F}{n D}\right)^{\frac{1}{3}}$	$\left(\frac{F}{D^{\frac{2}{3}}}\right)^{\frac{1}{2}}$

A *résumé* of the laws of similitude is given in a table of formulæ, which presents the subject in such concise form that it is worth reproducing. "When a satisfactory design of engine and hull is once arrived at, it is possible to make use of this table to design a new vessel not differing greatly in size from the model," as "any one of the principal elements can be deduced from it, if the others are given." The paper concludes with a discussion of similarity in trials and models of ships.

Coupling Boilers of Different Systems.

M. PIERRE SIGAUDY, in a paper read before the recent Paris meeting of the Institution of Naval Architects (*Practical Engineer*, July 5), expressed the opinion that the speediest method of removing the remaining scepticism as to the safety of water tube boilers is to fit together boilers of the old and new types "on the same ships, thus giving the possibility of getting up steam quickly, which is generally of great importance." He then presented an account of a successful trial of this arrangement made by the Société des Forges et Chantiers, at Havre, on the tug boat Adour No 3, built for the Bayonne chamber of commerce. This tug is 118 ft 1 in. long, 23 ft. 7¼ in. wide, 13 ft. 1½ in deep, 8 ft. 0½ in. in draft, and has engines of 700 h. p.

The conditions of trial were: speed of 11 knots during 6 hours, the coal consumption not to exceed 21 lbs. per h. p.; the getting up steam to be done within 30 minutes. "Of course it is most important for a tug-boat to get steam up as quickly as possible, especially when employed on salvage service." Two different kinds of boilers were put on board, "one of the

Normand type, and one return-tube boiler of the ordinary type. M. Sigaudy says they would rather have coupled two Normand boilers, had not the owners asked that at least one of the two should be of the usual type, as they feared for the results of two water-tube boilers." The Normand boiler had a heating surface of 1560 sq. ft., a steam space of 32.82 cu. ft., a water volume of 82.58 cu. ft., and a grate surface of 34.70 sq. ft. The return-tube boiler had a heating surface of 1232.55 sq. ft., a steam space of 176.45 cu. ft., a water volume of 345.13 cu. ft., and a grate surface of 38.73 sq. ft.

The experiment was embarrassed by the general arrangement. "The boiler of the Normand type is placed in the forward compartment, with its funnel forward and stoke-hold aft; the engines are in the center compartment, and the after compartment contains the return-tube boiler with its stoke hold placed forward. No special arrangement has been made for the steam and feed pipes, one single steam pipe making the communication between the two boilers through the engine-room, with a branch to each engine. In the same way the feed pipe is common to both boilers, and communicates with two independent feed pumps placed on the side of the engine room, each one of which is sufficient to feed the two boilers. A single pump was working during the trials. The boilers steamed satisfactorily during both the preliminary and the official trials." The time for getting up steam with the Normand boiler was, in the two trials, from 22 to 23 minutes. At the official trial for coal consumption, which lasted for 6 hours, the mean speed being 11 knots and the mean power 673 h. p., with 29.5 revolutions per minute, the consumption of coal was 1.81 lbs. per horse power per hour, the fuel used having been *briquettes d'Anzin*. The engines, running at full speed, indicated 731 h. p. The quantity of coal burned in each boiler was pretty nearly the same on each trial. These results are regarded as conclusive of the practicability of combining the two systems, under the most difficult conditions,—"that is to say, coupled and in different stoke-holds,"—and they indicate that any fear of unsatisfactory results under such conditions is not justified in practice.

A New System of Towing.

THE Shaw & Speigle steam-towing machine has met with such success that it bids fair to become an important factor in marine traffic. *The Chemical Trade Journal* says it has been adopted by the chief coal and ore transport companies in the United States, and that an experiment is now in progress to determine its practicability for towing tank barges carrying oil in bulk. Its distinctive feature is said to be that, by means of its driving and cushioning steam cylinders, there is provided an elastic steam cushion, without which the hawser would be continually straining and frequently breaking. A manilla hawser, although more elastic than a steel hawser, is very bulky to handle or to stow on a barge, and it also becomes very expensive on account of its ordinary wear and tear. A steel-wire hawser will last apparently for an almost indefinite time without stranding or even straining, as appears from practical use. In its principle and mode of working the tow barge is borne entirely by the steam pressure in the cylinders. The wire hawser is wound on a drum that is driven by a pinion gear on the crank shaft of the engine, which meshes with the gear on the drum shaft. This machine has a regulating reducing steam valve, in which the opening is increased or diminished according as the strain on the hawser increases or diminishes. The action of the machine is as follows: in a seaway, as the vessel pays off, thus increasing the strain on the hawser, the drum begins to revolve and to pay off the hawser; this action opens the regulating valve and increases the steam pressure in the cylinders until the pressure is sufficient to equal the strain. Then, if the strain increases on the hawser, the pressure in the cylinders will revolve the drum and wind the hawser in. In this way the machine is prevented from paying out the whole of the hawser, and only enough is paid out to relieve the extra momentary strain on the hawser, and thus prevent its

injury or its breaking. When the tow barge casts off the hawser, then the regulating valve is disconnected, and the machine becomes in effect a simple hoisting drum to be started to wind up the hawser. It is claimed that this invention is also well adapted for ocean steamers, as better assistance can be rendered to disabled vessels in bringing them to port than can be offered by any other means heretofore available. The mechanical principles upon which this system is based are so obviously sound, as to render it surprising that they were not sooner applied to cable towing.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*6. The Earliest Transatlantic Steamships. Ill. Samuel Ward Stanton (Covering the period from 1819 to 1855). Eng Mag-Sept. 3700 w.

†81. Cellulose Protection for War Vessels and for the Merchant Marine. Ill. B. P. Wiltberger (Abstract of a paper read at the stated meeting of the Franklin Institute, Feb. 20, 1895. Describes the construction and use of the Colome's leak arrester). Jour Frank Inst-July. 300 w.

136. Scotch Shipbuilding in June (Orders booked; ships launched; total output). Mech Wld-July 5. 400 w.

*139. On Water-Tube Boilers. Ill. J. A. Normand (Treats of necessary conditions for resisting intense firing; strains due to expansion of tubes; circulation as related to heat transmission; combustion; section of passage and length of travel of hot gases, etc. An able discussion). Steamship-July. 3600 w.

*140. The Royal Mail Steamer "Vega." Ill. (Descriptive). Steamship-July. 2000 w.

*148. Improved Method of Fitting Ship Plating. Ill. (A method patented some years ago but now coming into use). Marine Eng-July 1. 900 w.

*149. Syer's Apparatus for Raising Sunken Ships. Ill. (Vessels filled with water are sunk and attached to the ship to be raised. The water is then displaced in the lifting vessels by blowing air into them). Marine Eng-July 1. 700 w.

*150. On the Utility of Calculating the Whole External Volume of Ships, and Constructing the Complete Scale of Solidity from the Points of View of "Stability," "Tonnage," and "Load-Line." M. Daymard (The author thinks a uniform rule for computing tonnage possible on the line pointed out). Marine Eng-July 1. 1300 w.

*151. On Coupling Boilers of Different Systems. Pierre Sigandy (The practicability and advantage of coupling the old with the new systems is discussed). Prac Eng-July 5. 600 w.

*171. Distilling Apparatus on H. M. Cruiser "Terrible." Ill. Engng-July 5. 400 w.

*225. Ocean Towing of Petroleum Tanks (Describes the Shaw and Speigle towing machine, by which this tank-towing has been rendered possible). Chem Tr Jour-July 6. 400 w.

*247. Water-Tube Boilers (Discussion pro and con at the Royal United Service Institution). Trans-July 5. 800 w.

302. The Marine Gasoline Engine and Launch. Ill. (Descriptive of motor built by the Globe Gas Engine Co). Am Ship-July 18. 700 w.

*352. Clydebank Shipbuilding and Engineering Works. Ill. (Descriptive: interesting). Engng, Lond-July 12. Serial. 1st part 4500 w.

*355. The Laws of Similitude as Affecting Naval Construction. Abstract. J. Augustine Normand. Engng, Lond-July 12. 2400 w.

380. The Lake Steamer North Land. Ill. (Descriptive). Sci Am-July 27. 700 w.

398. New Gunboats. Ill. (Types; engines; armaments, etc). Sea-July 25 1600 w.

425. A Steel River Steam-boat. Ill. (Sections). Eng News-July 27. 650 w.

†457. The Yacht as a Naval Auxiliary. William McAdoo (The present growth in American yachting is regarded as boding well for the future both of the United States Navy and the Mercantile Marine). N Amer Rev-Aug. 3000 w.

502. The International Cup Races. Editorial. Sea-Aug. 1. 350 w.

*503. The Ship of the Future. Nathaniel Barnaby (Thornycrofts' steadying apparatus). Eng Rev-July 20. 1000 w.

*504. The Application of Hydraulic Machinery to Shipbuilding. Ill. Ralph Hart Tweddell. Eng Rev-July 20. Serial. 1st part. 800 w.

*505. The Launching of Heavy War Ships and Ocean Liners. D. Pollock. Eng Rev-July 20. Serial. 1st part. 1100 w.

*506. The Shipbuilding Resources of Different Countries. Eng Rev-July 20. Serial. 1st part. 1100 w.

*548. Tubulous Boilers in the French Navy. (Extract). John K. Robinson (Results of personal observation of the working of the Belleville D'Allest and the Niclausse boilers). Am Eng & R R Jour-Aug. 4000 w.

*599. The Continental Steamboat Services (A popular description of steamboats on European rivers and lakes). Fairplay-July 26. Serial. 1st part. 1500 w.

*622. French War Vessels. Ill. (Descriptive). Eng, Lond-July 26. 1000 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

The Field Engine.

UNDER the title, "A New Departure in Steam-Engine Economy," *The Engineer* (July 5) editorially criticises a paper recently read before The Institution of Engineers and Shipbuilders, in Scotland, by Professor Jamieson, of the Glasgow and West of Scotland Technical College. The paper gave a description of the new heat engine invented by Mr. Edward Field, and a report of a test made with this motor, wherein it is stated that remarkable results were achieved. A description of the motor is quoted from Professor Jamieson's paper.

"A Roots blower, driven by the engine, draws fresh cold air from the engine-room, and forces the same through a series of heating pipes placed in the main flue between the boiler or boilers and the chimney. This heater, therefore, occupies pretty much the same position as a Green's economizer. The air was maintained, in my experiments, at a mean pressure of 1134 lbs. on the square inch, and delivered to the ends of the cylinder at a mean temperature of 553° F., and to the valve-casing jacket at about 380°. This hot air was admitted to the cylinder through special cylinder covers, each containing five inlet valves, which automatically opened inwards as soon as the exhaust steam commenced to escape. These valves continued open until compression commenced, being held close to their seats by light spiral springs. Consequently the whole internal surface of the cylinder was heated up to a temperature far exceeding that of the steam, thus preventing the possibility of condensation taking place within the cylinder. Under these circumstances I got the excellent result of 18.6 lbs. of steam per indicated horse-power per hour, from a single cylinder non-condensing engine,—a result which, as far as I can learn, has never been equalled by any other method of using steam in a single cylinder, and without subsequent condensation." Now, Professor Jamieson is a well recognized authority in steam engineering, and is known to be an accomplished engineer. *Prima facie*, the results asserted by such an experimenter would seem to compel acceptance; *The Engineer*, however, and not unreasonably, thinks some of the indications supplied by the indicator and the pressure gages are puzzling. Being thus, they lead to some question whether the results alleged are altogether trustworthy.

"The diameter of the cylinder of the engine tested was 19 in.; the length of stroke 3 ft. The mean indicated horse-power was 136.75; the brake horse-power was 104.6. . . . The engine has double Corliss valves, one for admission at each end of the cylinder. But they are quite close together, and the incoming steam has to pass over surface cooled by the exhaust. The steam from the boiler passes through a superheater. This is not described, but appears to be a vertical cylinder traversed by vertical pipes, through which some of the hot waste gases flow while the steam fills the cylinder. There is not a specially free course from the boiler to the cylinder valve chests. Yet we find from the table of results the pressure by the steam gage on the boiler only varying between 112 lbs. and 115 lbs. The pressure in the cylinder given by the indicator varied between 112 lbs. and 115 lbs. Sometimes the initial pressure in the cylinder was higher than the boiler pressure. Very frequently the two pressures were identical. In no case was the valve pressure more than 1 lb. in excess of the initial cylinder pressure. This was certainly curious."

"Professor Jamieson makes no attempt to explain a circumstance which seems to be unique, at least under the conditions. Sir D. Gooch is said to have got a valve-chest pressure greater than the boiler pressure in a locomotive, but not, it will be understood, steadily greater. The result was produced only by the hammer action

of the steam when the valve suddenly closed the admission port. It is a pity thst Professor Jamieson has said nothing in explanation; and it is a pity, because such a result—or, rather, the statement of such a result—tends to raise a doubt in our minds about the accuracy of the indicators. We are led to suspect that the springs were weak, and that the indicated power was apparently greater than it was in reality,—a suspicion strengthened by the large excess of the indicated over the brake horse-power. However, we may put this on one side, and take it for granted that Professor Jamieson's figures are right. Only then we are puzzled to know how the steam managed to find its way into the cylinder with sufficient rapidity to keep the admission corner of the diagram nearly square. Professor Jamieson very properly calls attention to the unusual shape of the diagrams. They are not at all like Corliss diagrams, but rather like those taken from a locomotive much linked up, the compression being enormous, while expansion takes place precisely down to the atmospheric line, and no lower. It has been said that it is more difficult to be absolutely last in an examination than absolutely first; and we cannot imagine anything more difficult than to make certain that the exhaust port shall open precisely at the moment that the pressure inside the cylinder and outside it are identical, and this not only when the engine was indicating full power, but at one-fourth power. Professor Jamieson is certainly justified in saying that the four fac-simile diagrams which he gives demand special attention from their unusual shape."

Without further following this criticism to its conclusion, we may say that *The Engineer* seems to us to succeed in showing that, under the conditions when the indicator diagrams were taken off, the cylinder contained a large quantity of compressed steam and air at the end of the stroke, and that the indicator would not and did not "account for all the feed water at the moment the admission port closed, which it would do, of course, if there had been no initial condensation." The results stated must be confirmed before they can be accepted with confidence by engineers.

Boilers and Boiler Settings.

A REVIEW of up-to-date practice in the setting of boilers is presented by L. Summers in *Electrical Engineering* for July. The gradual change in ideas regarding boiler settings that has taken place during the last 5 years is considered, not radical, but in the line of a gradual adaptation to the tendency toward higher pressures and greater economy in fuel.

The most noticeable change is increase of heating surface in proportion to grate area. Whereas a ratio of 30 to 1 was formerly considered good practice, we now have 45 to 1, 50 to 1, and in some cases even more than 50 to 1. An old rule was to make the ratio of grate area to heating surface twice the number representing the pounds of coal burned per hour, and it is still followed by some steam engineers.

There is also a tendency toward increase of the size of tubes. From 3 to 3 1/2 in. used to be the practice in stationary boilers; now 4-in. tubes are common. Area of chimney is now made about equal to total area of cross-section of tubes. Heights of chimneys are not so great since their areas have been increased. The strength of draft is now equal to about 0.5 to 0.75 in. of water. It is found that "the maximum power can be developed with this draft, and a consumption of from 20 to 30 lbs. of coal per square foot of grate obtained without the temperature of the escaping gases exceeding 500° F., while their average temperature at a moderate rate of coal consumption is below this." A chimney 100 ft. high, with the area above named, will usually give a draft of from 0.6 to 0.7 in. of water. "Many old rules are given for the proportion of chimneys. For instance, a common rule is that the height of the chimney shall be twenty times the diameter of flue; another rule, which is probably derived from the above, is that the height shall be twenty-five times the area of the flue. It is evident that these rules are not applicable to all conditions, and are entirely empirical."

The late practice of the Hartford Steam Boiler Inspection and Insurance Company

is to make the width of the furnace 6 in. less than the diameter of the boiler, and to give the side walls a uniform batter, such as will leave a space of 3 in. between the boiler and the walls at the top, where the walls are run in to meet the shell. The heated gases are thus prevented from infringing against the side walls, and rise directly to and against the shell. "It also increases the volume of the combustion chamber, and provides for a more thorough mixing of the gases and a more complete combustion. The space of 3 in. between the shell and walls admits of inspection and cleaning, and also, in a great measure, prevents the lodgment of soot and ash. In place of the large combustion chamber beyond the bridge wall, almost all modern settings provide an inclined or curved flue. It is found that the tendency of the heated gases is to follow the boiler contour, and that, inasmuch as the increased space beyond the bridge wall has no tendency to produce a more thorough mixing of the gases, and the current is confined to the upper part of the chamber, the lower part adjacent to the bridge wall is not only useless space, but also allows an increased chance for radiation and leakage of cold air, as well as convenient corners for the lodgment of ashes and soot. By filling in this space and giving it a sloping bed, cleaning is greatly facilitated, as the cleaning door may be placed on a level with the floor and the refuse readily hoed out without even necessitating the cooling down of the setting. Another advantage is gained by lowering the cleaning door, as it is thus put below the direct action of the current of gases and does not receive the impingement of the flame."

Grates are now placed as near the boiler shells as the necessity of thorough combustion will permit. For anthracite coal 24 in. is the approved practice, while for soft coal 30 in. is the distance. These distances have been adopted by the Hartford Steam Boiler Inspection and Insurance Company.

A setting designed by Mr. James L. Ayre has been favorably received by western electric-lighting plants. In this setting a curved flame-bed is made to replace the former inclined bed behind the bridge wall, the curvature of the bed corresponding with the curvature which the flame naturally takes through the chamber after passing the bridge wall. A construction is also used which is thought to secure a more uniform distribution of the hot gases in the tubes. Much attention has been given of late to methods of setting designed to support the boiler in such manner that fissures will not occur in the setting, these allowing cold air to leak in and intermingle with the hot gases. Double walls with an intervening air space have been employed for this purpose.

Figuring Drawings.

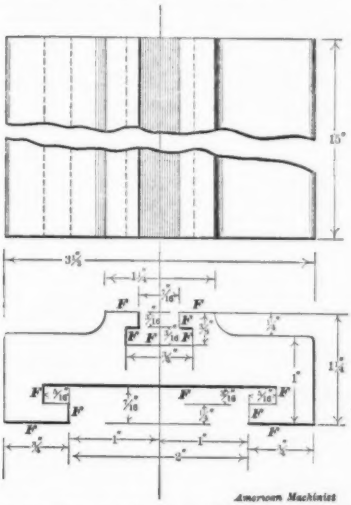
IT has hitherto been the custom among draftsmen to figure drawings in such manner as to bring the figures into the horizontal position for reading off dimensions; the lines indicating the points between which the dimensions are taken must also be brought into the horizontal position. We have often mentally questioned the advantage of this convention, and we are glad that a practical mechanic and draftsman has brought the method under criticism. Mr. Francis W. Clough, in *American Machinist* (June 27), gives an illustration of a drawing so figured that both horizontal and vertical dimensions may be read without turning the sheet, and he gives very sensible reasons for preferring this plan in general practice to the old method. He says:

"The ordinary method reminds one of some proficient letter-writers, who, having filled all of the horizontal space on their paper, extend their manipulations on the vertical borders of the letter, encroaching on the regular line writing, and before they finish they get around on the top of sheet, sometimes bottom side up, sometimes right side up, until the receiver is often puzzled as to where to begin, how to read, and when he is done.

"The argument is sometimes offered that all figures should read from the same direction of sight as the indicating points designate. That is simply an argument; while the opposite simply replies that any

dimension line having two terminating points, with an opening in the midway of said line to receive the figure, is equally intelligible whether the figure is one way or another, and more readily made in the drawing-room and read in the shop in the method illustrated.

"Some years ago a venerable pattern-maker objected to my method, and argued to me that there was a greater liability to mistakes, etc., in reading. I tried to show him that the greater liability to error exis-



ted in the received method; he said he could read a drawing with measurement figures placed for vertical lines as per ordinary method without inclining his head at all, but he had swiveled his head so many times that he did not observe that when at work he got it around 45 degrees; perhaps he had got that amount of lost motion in his neck joint. But I kept on making drawings the same way, and he kept making patterns from them, and you would be surprised to know how well he liked it after a little while. That man was in a rut on figuring drawings; but later he stood up erect, and looked directly in front of him, and read my drawings the same as he would read any other printing. There is a fitness, correctness, and ease in conveying properly all intelligence, and the more naturally it can be read and understood the more mechanical will it also be.

"The figure represents an ordinary square-tongue slide having a T-groove on the top side, 15 in. long, 3½ wide, 1¼ thick; the letter *F* designates what parts are to be finished, so that the pattern-maker can make the pattern, and allow for finish. The machinists can do the machine work from the same drawing, and read measurements from before them without trouble, and with less liability to read wrong than from a bias, twisting glance, as on ordinary drawings."

Weight of Shafting as Related to Economy of Power.

THAT shafting heavier than is required for the work to be performed (of course allowing a reasonable factor of safety) will consume and waste power through the friction of its superfluous weight hardly needs to be stated. The fact will be universally admitted, and its reassertion would be trite. It is, however, not so well understood that the weight of a shaft, while it will determine the static friction upon bearings whose coefficients of friction are known, does not alone determine the power which will be consumed in a unit of time in overcoming the static friction. Two other factors—the diameter of the bearing (or the circumference) and the velocity of rotation—influence the amount of power required to drive shafting. Weight being constant, the power required to perform the work of friction will be as the product of the diameter (or of the circumference) into the number of revolutions per unit of time. The total work in foot-pounds per hour due to any particular bearing will be the product of the coefficient of friction, the weight in pounds sustained by the bearing, the circumference of the bearing in feet, and the number of revolutions made by the shaft in 1 hour. To obtain the horse-power necessary to overcome this friction, the product may be divided by 33,000. Applying this rule, many would be astonished at the work so consumed throughout a large manufactory, wherein shafts and counter-shafts are numerous.

The *Boston Journal of Commerce* (July 6), discussing this waste, says that its reduction has been sought by the use of tubular shafting. Now, while a tube of a given weight is stronger than a solid round bar of the same weight, its diameter is greater, so that this plan amounts to an increase of one of the factors, while reducing another. Though one of these factors—the weight—may be decreased, the diameter, to gain equal strength, requires to be increased so much as to greatly neutralize the effect. This fact, taken in connection with the greater cost of hollow shafting, has prevented the use of the latter to any considerable extent. The *Boston Journal of Commerce* writer maintains that, in the designing of shafting, the factor of safety is made larger than necessary. He adds:

"Did any one ever hear of a light shaft breaking? The shafts that break off are always heavy, and usually become too heavy and non-elastic,—too rigid. A shaft that is elastic has some spring to it, and never breaks unless structurally defective; and many a broken shaft might have been saved, if it had been lighter and more elastic. Right here lies the solution to the problem. All shaftings should be made of the best and most elastic iron, and then it should be light in proportion. If the iron in a shaft possesses life and elasticity, as it should, comparatively light shafts would, with the greatest ease and safety, do the work now being done by thousands of heavy shafts in every manufacturing locality, and thus save thousands of horse power of now wasted force that could be applied to useful work."

To the question about breakages of light shafting we can answer affirmatively, and doubt not that others can do the same. But there are other questions besides liability to breakage that must be considered in designing shafting, which appear to have been ignored by the writer quoted. There is the question of size of bearings, so that they may run without heating, and of sufficient rapidity to prevent the binding of bearings in boxes and to avoid undue torsional yielding. In our opinion less power is wasted needlessly by undue weight of shafting in general practice than by imperfect alignment. There used to be excessive weight in pulleys, but in these days of careful designing we think this fault is not so common as it was a few years ago.

The Smith's Craft.

IN the art of forging as developed in these later days of machines that not only work, but seem to work almost intelligently and consciously, *The Practical Engineer* says that "less thought, judgment, and intelligent manipulation are required" than used to be needed. This may perhaps be true of the operators who feed heated blanks to drop forging machines, but we cannot concede that die-making, the regulation of heat, the gaging of the strength of blows, and the selection of material for different kinds of work require less intelligence or less judgment than was required in the old-time forging. It is true that steel has largely superseded iron, and that much light work is now done under the drop-press with or without dies, and it is admitted that "iron requires more thought and judgment in working than mild steel"; but, while in this respect the demand for mind-work has lessened, it has rather increased on other lines.

A certain care and knowledge, and even some experiment, that once were required in working different kinds of iron have been rendered less requisite by modern methods, as our contemporary states. "Not only in such work as drawing down, upsetting, bending, arrangement of fibre, and general manipulation of this character is the difference of wrought iron and steel apparent, but also in welding, punching, and drifting. All these are more easily done in mild steel than in common wrought iron. The presence of scale in wrought iron will effectually prevent formation of sound weld. In mild steel, not over heated, a weld can generally be depended upon. Punching and drifting out are risky in reedy iron, opening out the grain, dividing the fibres, and producing cracks more or less wide according to circumstances; whereas mild steel can be punched and drifted with the utmost facility and with practically no risk, because

it is homogeneous, without grain, and highly ductile." A certain skill of hand and eye which the old smiths required is undoubtedly becoming rarer from the introduction of machine forging. "Very heavy work used to be done well by building up with welds, which is now drawn down under hammer or press from solid bars or slabs. Not only does the strength of some classes of work of medium size suffer in consequence, but far less skill is demanded of the smith, less judgment, less precision of eye and hand,—less, too, from his helpers. Again, much good heavy work used to be done by a gang of men swinging sledges in concert, raining a rapid succession of blows upon a forging, or tupping with the monkey, or closing a large weld. This is now all past. In smaller work, too, numerous similar pieces are formed, or finished in dies or stamps, which have become almost necessary appendages to steam hammers and presses. Some of this work formerly afforded great scope for manipulative skill, and the older smiths could finish it with smoothness and accuracy, approximating to that of machine work. But relatively little skill is required when finish is imparted to dozens of similar articles in dies."

We do not share the regret in which our contemporary indulges at the decay of skill, which it regards as an evil. Better, more accurate, and cheaper forging is done by modern methods than by those whose decay is lamented. To regret these is simply to take a wrong view of evolution, and thus to acquire the idea that progress is retrogression.

The Machine Shop as an Educator for Molders.

IN the *Foundry* for July M. H. Hansen asserts that "the rank and file of machinists have received a better education than molders," and that it is unfortunate "that molders are not better acquainted with the machine shop and machines." As to the assertion of inferior education on the part of molders, it rests solely on the assertion of Mr. Hansen, who does not back it with evidence. As a consequence of this alleged fact, it is stated that the machinist is able to converse on many subjects of which the molder knows nothing. Possibly the molder could also talk about some things of which the average machinist is ignorant, but this possibility does not seem to have occurred to Mr. Hansen. Yet there is some truth in what follows.

"The total extent of many molders' familiarity with the machine shop is geographical, and is acquired in the search for a good hiding-place to locate a bottle. Many a casting with a big N. G. can be charged to a want of information in regard to what it was intended for or the position it would occupy when assembled. Many molders will probably say they have no time to monkey around the machine shop, yet nearly every foundry has a few who may find several chances during the week to look through this interesting chamber. At recess, while some are playing ball, others watching them and spinning yarns, these are looking through the machine shop, inspecting castings here and there being finished. At the end of the year who are the best molders,—those that played ball, or those that investigated the machine shop? I say the latter by far."

A machine shop is a good school for anyone who has a receptive mind, and good perceptive faculties, and who is desirous of learning what may be learned there.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

32. Use and Abuse of Belts. William F. Roberts (A popular and practical treatment of the subject). Sta Eng-June. 5000 w.

33. Drilling Holes (A practical talk on hand drilling). Sta Eng-June. 900 w.

69. Weight of Shafting (Treats of waste of power by superfluous weight of shafting). Bos Jour Com-July 6. 900 w.

We supply copies of these articles. See introductory.

94. The Band Saw. John M. Richardson (Practical use of band saw). Am Mach-July 11. 1500 w.

157. Shop Tests of Locomotives, with Editorial (Report of committee appointed in 1894 to report on proposed tests of locomotives at Purdue University). Ry Age-July 12. 2500 w.

250. A Method of Casting Car Wheels. Ill. (Method invented by Mr. Joseph Carr of Wilkesbarre, Pa. Employs a hollow, instead of solid core. Superior results claimed). Ir Tr Rev-July 11. 1500 w.

303. Lignum-vitæ for Bearings, Crosshead Gibs, etc. (Practical experience with). T. McKim Chase. Am Mach-July 18. 800 w.

*311. Dies, Blocks, and Appliances for Engine Smiths. Ill. Joseph Horner (Practice of drop forging). Prac Eng-July 12. Serial. 1st part. 2300 w.

378. The Machine Shop as an Educator of Molders. H. Hansen (What the molder may learn therein). Foundry-July. 1400 w.

385. Calipers. A Mechanic (Suggestions for improvement in construction and use). Am Mech-July 25. 1800 w.

*489. The Craft of the Smith. Editorial (Differences between modern forging and that of the past, with reasons for present practice). Prac Eng-July 19 1500 w.

501. Submitting Drawings of Machines. Editorial. Ir Age-Aug. 1. 700 w.

513. Value of Degrees of Belt Contact. D. N. Ricker (An experimental determination). Power-Aug. 200 w.

Steam Engineering.

35. Compound Engines (Editorial. Analysis of the question "Which is the more economical in a non-condensing compound engine (ideal or real), 22 and 40 by 60 running at 70 revolutions per minute with 120 pounds pressure by gauge, to cut off one-fifth in both cylinders or one-sixth in the high pressure and one-quarter in the low?") Power-July. 1300 w.

36. Ratios of Expansion, Mean and Initial Pressures (Table for computing mean and initial pressures, points of cut-off, etc., with explanatory text). Power-July. 1500 w.

37. Valve Model for Horizontal Engines. Ill. (Descriptive of a model combining various standard types of valve gear, for the use of draughtsmen and designers). Power-July. 800 w.

38. Condensers. F. R. Low (Theoretical and practical). Ill. Power-July. 6000 w.

39. Single Plate Pistons. Ill. (Details of construction in designs for). Ry Rev-July 6. 1100 w.

75. Specifications for Boiler Tubes (Editorial. Points out a difficulty in the general adoption of standards for boiler tubes arising from varying local conditions; notwithstanding the standard is approved). Ry Age-July 5. 500 w.

92. Compounding—Its Thermal and Mechanical Advantages Under Proper Conditions, W. H. Booth. Am Mach-July 11. 1500 w.

96. The Development of the Experimental Study of Heat Engines. W. C. Unwin (Historical review). Sci Am Sup-July 13. 5200 w.

129. Fuels and Firing. Lord's Mag-July. Serial. 1st part. 1500 w.

130. Chimney Construction (Practical and popular). Lord's Mag-July. 2500 w.

131. Indicator Uses (Popular). Lord's Mag-July. 1500 w.

132. Engine Foundations (Practical and popular). Lord's Mag-July. 1500 w.

133. Main Steam Connections. Ill. (Practical and popular). Lord's Mag-July. 1300 w.

134. The Care of Boilers (Practical and popular). Lord's Mag-July. 1800 w.

158. Steam Carriages: Where are they Carrying Us? (Editorial on the recent races of steam wagons from Paris to Bordeaux. Considers such a contest yet impossible to America). Pro Age-July 15. 800 w.

*172. Steam Engine Trials (Editorial. General review of present status of knowledge, and present practice in testing steam engines). Engng-July 5. 1900 w.

*174. Locomotive Piston Rods. Ill. H. Rolfe (An important, practical discussion of the question of fitting piston rods to cross heads). Engng-July 5. 5300 w.

179. Some Ideas Concerning Boilers and Boiler Settings. Ill. L. L. Summers (Up-to-date practice). Elec Engng-July. 2400 w.

*208. Steam Engine Problems. (A critique of a criticism of Prof. Unwin's James Forrest lecture in the Engineer). Elec Rev, Lond-July 5. 1400 w.

*221. A New Departure in Steam Engine Economy. Editorial (A critique on Prof. Jamison's report of a test of the Field heat engine). Eng, Lond-July 5. 2300 w.

*273. Boiler Explosions. (Abstract of report for 1894 of the Chief Engineer of the National Boiler and General Insurance Co., Limited). Mech Wld-July 12. 1900 w.

*295. A New Type of Steam Motor. (Remarkable economy by use of super-heated steam in a motor designed by W. Schmidt of Aschersleben). Ir & Steel Tr Jour-July 6. 900 w.

*354. The Efficiency of Heating Surface in Steam Boilers (Theoretical discussion and review of experimental researches of Blechynden, Stromeyer, Durston and Fletcher). Engng, Lond-July 12. 1600 w.

*360. Clearance in Steam Engine Cylinders (Editorial. Anomalous effect of clearance). Eng, Lond-July 12. 1800 w.

404. Boiler Feed Waters; Their Treatment. W. D. Jameson (Mixture of sugars; the boiler a galvanic battery; deleterious action of oil in steam boilers). W Elec-July 27. 3000 w.

514. Valve Gears. Ill. C. W. McCord, Jr. (Principles of valve gear and applications of graphical methods in laying out valve gears of various types). Power-Aug. Serial. 1st part. 2800 w.

646. Drainage of Heating Coils and Steam

Pipes. Allehassett, in Louisiana Planter. Sci Am Sup–Aug 10. 2000 w.

*672. The Mechanical and Electrical Regulation of Steam Engines. Ill. John Richardson (A paper dealing with the practical results which can be obtained from a great variety of types of governors that have come under the author's personal observation, and the causes of their failure or success). Ind & Ir–Aug. 2. 6000 w.

Miscellany.

*2. Emancipation of Labor by Machinery. A. E. Onterbridge, Jr. (An old economic delusion exploded). Eng Mag–Sept. 3500 w.

13 Mechanics of the Ferris Wheel (With Stiff Spokes). I. P. Church. (Treats mathematically the inter-dependence between the stresses in the bars of a Ferris Wheel (with stiff spokes) and their elastic changes of length). Eng News–July 4. 700 w.

†19. Injuries to Workingmen from Defective Machinery (Mutual responsibility of employers and employed). San–July. 6000 w.

34. Fifteen Thousand Horse Power Reversing Rolling Mill Engine. Ill. (Descriptive). Power–July. 700 w.

41. Excavator for Sinking Cylinders. Ill. Clement F. Street (Descriptive). Ry Rev–July 6. 300 w.

42. A T-Square and Its Mountings. Ill. W. A. Gabriel. Ry Rev–July 6. 500 w.

†80. The Theory of the Air-Lift Pumps. Ill. Elmo G. Harris (A mathematical analysis believed to be the first attempt at such a treatment of the theory of the air-lift pump, with tables of results). Jour Frank Inst–July. 3300 w.

91. A Job of Foundry Work. Ill. (Describing moulding of 180 lb. bull-wheels at Deering Reaper Works, done at cost of 16 cts.). Am Mach–July 11. 2300 w.

93. A Horse-Power Planimeter. Ill. (Describes an instrument which reads horse-power directly from indicator cards). Am Mach–July 11. 800 w.

138. Who Invented the Rolling of Metals by Grooved Rolls? W. E. Durfee (Throws doubt on the general belief that the invention should be accredited to Henry Cort, and quotes Latin and Italian authorities which seem to carry the invention back to the early part of the 17th Century). Bul Ir & Steel Asso–July 10. 700 w.

165. Application of Blast Furnace Gases to Gas Engines. Abstract. W. H. Watkinson (Describes what the author considers a much more efficient method of utilizing the thermal energy of these gases). Am Mfr & Ir Wld–July 12. 600 w.

*211. The Red Car Boiler Explosion and Its Influence on Gas Engine Practice. W. H. B. Elec Rev, Lond–July 5. 800 w.

*220. Steam, Oil and Gas Engines at the Royal Agricultural Show. Ill. Eng, Lond–July 5. 3600 w.

*222. Good Enough (Why so many patents are taken and why so many prove unprofitable). Eng, Lond–July 5. 1400 w.

304. Gas vs. Electricity. William Cox (Comparison of results in use of motors and Welsbach system, with electricity for illumination). Am Mach–July 18. 1500 w.

305. The Story of a Great Invention. (The Appleby Twine Binder). Ill. H. L. A. Am Mach–July 18. 5600 w.

376. A Visit to the Foundry of William Sellers & Co., Incorporated, Philadelphia. Ill. Foundry–July. 2200 w.

377. Pressure on Molds. Herbert M. Ramp (A practical discussion of an important point in foundry practice with 6 tables of pressures under different conditions). Foundry–July. 1800 w.

379. Foundry Heating and Ventilating. Foundry–July. 400 w.

384. Experiments with Foundry Iron and Aluminum. C. G. Taylor (Effect of aluminum when added in the commercial way in the foundry, with table of results). Am Mach–July 25. 1300 w.

386. The Bicycle vs. the Horse. "Quirk" (Computation of work required to propel bicycles). Am Mach–July 25. 1200 w.

387. Design of Water Wheels. Samuel Webber (Notes relating to introduction of various turbines and their inventor). Am Mach–July 25. 800 w.

405. New Forms of Friction Brakes. Ill. W. F. M. Goss. Safety V–July 15. 2500 w.

406. The Power Absorbed by Rope and Belt Transmission (Experiments made by the Société Industrielle du Nord de la France to determine comparative efficiency). Safety V–July 15. 2200 w.

500. Renewing Old Steel Rails (Describes a process and plant). Ir Age–Aug. 1. 1200 w.

515. The Prevalent Method of Calculating Water-Power and for Testing the Efficiency of Water Wheels Produces Erroneous Results. F. M. F. Cazin (Compares and discusses equations of Cazin and Trautwine, for computing water-power). Power–Aug. Serial. 1st part. 2000 w.

616. Adiabatic Curve Construction—Uses of Logarithmic Section Paper (Describes a method of drawing adiabatic curves whereby there seems to be a great saving of labor effected). Am Mach–Aug. 1. 1600 w.

625. Fly Wheel Arms. Ill. C. V. Kerr (A mathematical discussion). Am Mach–Aug 8 2500 w.

644. The Horseless Carriage Races (Rules of the international, English and American races arranged between the *Engineer* (London) and the Chicago *Times Herald* and to take place Nov. 2, 1895). Sci Am–Aug. 10. 1000 w.

*669. Vegetable Lubricating Oils (Principles involved in judging of their authenticity, etc). Irm–Aug. 3. 2200 w.

*673. Hydraulic Stoking Machinery and Labor Saving Appliances. Andrew S. Biggart with Discussion (Changes due to mechanical appliances, especially in gas works). Ind & Ir–Aug. 2. 5000 w.

MINING & METALLURGY

Fighting a Coal-Mine Fire.

A GRAPHIC account of the remarkable struggle to overcome the fire which occurred October 8, 1894, in the Luke Fiddler colliery, near Shamokin, Pa., is given by Mr. Baird Hallerstadt in the *Colliery Engineer* for August. The workings in this mine are very extensive, there being 28 miles of gangways, while connected with them are the workings of two large active collieries and one abandoned one. The fire originated through the carelessness of a carpenter who used a naked light, contrary to orders, while repairing an air-box. The flames rapidly spread, destroying the fan and consequently stopping all artificial ventilation, and soon caught the heavy timbering of an old underground engine station and the timbers throughout the adjacent workings. A heavily-timbered shaft, once on fire, formed a vent for the draft, and the whole became a roaring furnace, likened by the author to a veritable Inferno. This is what confronted the first party of heroic miners, led by the superintendent and an inspector, when they reached the spot, advancing with pipe and hose to battle with it. There were then sixty men in various parts of the mine, and to rescue them became the first effort. Volunteers were called for, and, as always happens in such cases, there was no hesitation about responding. Three relief parties were formed, who were so fortunate as to reach and remove all but two of the miners under ground. Two others, found and directed toward safety, became bewildered and lost their way. The city firemen and the miners made desperate efforts to subdue the fire by direct means, sending water down through rope holes which had been drilled from the surface plant to connect with the old shaft, and also through two 3-in. lines of gas pipe run down the new shaft and turned toward the fire. But soon the smoke and the terrific explosions of fire damp precluded all chances of success in this way, if any had existed. There remained but one thing to do,—flood the workings, not only to save this mine, but also the other valuable collieries connected with it. There were still four human beings below ground, and, had there remained the slightest probability of their being alive, the plan of flooding would not have been adopted. After a consultation of mine officials and State mine inspectors, at which every point was carefully weighed, the superintendent at the outset declaring that he would sacrifice the entire colliery rather than flood it if the slightest hope of rescue of the men alive or dead remained, it was determined that no such chance existed. Preparations were at once made to drown the workings, and all known openings through which air could enter were battened down with plank and clay. It was also decided to fill up the burning underground shaft with culm run in with water through the rope holes. A track was laid to the culm bank, pipes run to the pump, and 4 days after the fire started the slushing began. Ten days later it was completed, after sending down 2311 carloads, weighing 4622 tons. To drown out the colliery the waters of Coal Run were sent in through an adjoining mine, two 8-in. pumps handling this water, while what water could be spared from the town supply was also used. It was necessary to build two dams,—one in a tunnel, the other in the shaft. Details of the construction of these stops are given by Mr. Hallerstadt, an interesting feature of the tunnel dam being the insertion of a large pipe serving as a manhole through which a man could pass to make examinations without the necessity of breaking through the dam itself. It took 3 months to fill the mine to the degree desired. After the water had been left standing what was thought to be a sufficient time, the mine was examined and found not to contain a spark. Water standing above the tunnel level was then drawn off through the pipes in the dam. To remove the lower water, pumps with a

capacity of 7,000,000 gallons per day were set up, supplemented by baling tanks raising 3,000,000 gallons daily. It was expected that the mine would be clear on August 1, —about 6 months after beginning the work of removing the water.

Economies in Coal Mining.

IN the introduction to a paper on the distribution of power in collieries, by Mr. L. B. Atkinson, read before a recent meeting of the South Wales Institute of Engineers printed in the *Colliery Guardian* of August 2, the author makes some very pertinent observations on the present situation, as to relation of costs to product, in English coal mining as contrasted with that in other industries. His view is rather pessimistic. Speaking from experience of some years, he declares that the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This he ascribes to the fact that economies which are studied and made use of in other engineering enterprises and in manufacturing are considered in coal mining rarely, or, at most, only in a minority of cases. This may seem a rather sweeping assertion, but Mr. Atkinson supports it by adding: "This broad fact must appeal to every mind, that, whereas in almost every manufacturing process or industrial operation the product per man has probably doubled and the consumption of fuel has been halved within the last 15 years, in coal mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so." To the explanation sometimes offered,—that this is due to the stringency of mine legislation,—he answers that legislation has also largly affected other industries, and that therefore the result cannot be altogether attributed to this cause. Without enumerating all the causes which might be effective, the author states that, broadly, it appears to him that what is needed in coal mining is what has been done in every other department of industry,—namely, the lowering of the cost of labor and of material per ton by increasing the product per man and per pound of fuel. In brief, Mr. Atkinson's scheme involves the following means: (1) improved organization, both in working, and more especially in the original laying out of the system of working, a colliery, and in the means for doing it; (2) more supervision underground by well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse power, and more economical production of that power. "In short," says the author, "substitute brains and mechanical power for human labor." It is the third class of economies that he especially deals with in the paper under review, but lack of space forces us to neglect the practical details. It will be noticed, however, that what Mr. Atkinson says in a general way as to coal mining applies to other branches of mining as well.

Mining Leases.

CUSTOMS vary widely in various parts of the world as to the arrangement entered into between lessees and owners of precious metal mines. The general idea of the system originated in the "tribute work" of copper and tin mines in Cornwall, but, as applied to gold and silver mines, there are naturally many variations. Mr. Francis F. Freeland's notes on the practice in the Rocky mountain region, communicated in a paper read before the American Institute of Mining Engineers, and the specimen examples he gives, will prove suggestive to mine owners and miners elsewhere. In the west there are many mines worked in patches by lessees, to say nothing of other cases where the whole mine is leased outright. In the former case the company has its own foreman or inspector, and usually employs engineman, pumpman, and perhaps other workmen. Mr. Freeland cites cases in which the company advances a "footage," amounting to a third or a quarter of a fair contract price, to start a lessee having no capital and no ore in sight, enabling him to purchase supplies, etc.; and other cases where, for the same purpose, the company takes an interest in its own lease, advancing its share and getting it back, in addition to the tribute rate, when the ore is

sold. Another help rendered by the company is to do the permanent dead work, in order to insure good workmanship, though a certain amount of development work is required also of the lessees. The author states that it is the common custom to give leases for six months, on a strip of vein 150 ft. long and from level to level. The company sells the ore.

Mr. Freeland considers the lease system especially suited to narrow veins of good grade, where careful placing of the shots is required to keep the ore clean and to save it all; and he rather grimly remarks—perhaps from experience—that it has advantages in a district controlled by a strong labor organization. He says that, as the workmen are interested in the product, they require less watching, no unnecessary dead work is done, and the minimum amount of supplies is consumed; that, with careful inspection, many mines can be systematically opened in this way, with profit to the owners or small danger of heavy losses.

There is much to be said for and against leasing. Some managers object to it because they think that, as a rule, the mine is left in bad shape as to supports and generally ragged. There is another consideration: Mr. Freeland assumes the case of companies having some working capital, but it also often happens that mines are leased simply because the owners are unable to work them themselves, while lessees better provided are willing to take chances of finding ore.

A form of contract is appended, together with a scale of royalties on silver ore, showing percentage rates for various grades. The scale runs from 10 per cent. on ore containing less than 20 ounces up to 70 per cent. on ore containing over 250 ounces.

The Dry Process of Gold Crushing.

IF our valued London exchange, the *Mining Journal*, paid more attention to metallurgical practice in the United States, instead of almost confining its observations to the Transvaal and Australia, it would not have fallen into the error of assuming (as it does in its issue of July 20) that dry-crushing stamp batteries are a new thing. Such batteries have been in use for 30 years, and in great number and large capacity. True, they were used for silver ores, but, so far as the crushing is concerned, there is no difference. Before smelting took the lead, and while silver was a more profitable product, nearly half of the silver produced in the United States was extracted in mills having dry-crushing batteries and using the chloridizing-roasting-amalgamation process. However, as to the dry-crushing of gold ores the *Journal* has much of interest to say. It calls attention to the fact that in many parts of the world—particularly in Central and South America, India, and lately in West Australia—the profitable working of [some] gold and other mines is simply prevented by lack of water for the batteries. It goes on to say that "the objections urged against dry-crushing are the production of excessive dust, and the difficulty of substituting other methods of gold extraction for wet amalgamation by means of mercury over the plates. So far as the dust difficulty is concerned, it may be met by discarding the stamp battery altogether, and using machines with inclosed crushing gear, either in the form of revolving balls or rolls. But, apart from the mechanical difficulties which attach to these appliances, mining engineers have, as a body, a strong preference for the stamp battery as a means of fine crushing for ores. The dry crushing movement has certainly taken a strong step forward since it has been proposed to adapt the ordinary type of stamp battery to it. This is done by means of pnuematic tubes which convey the pulverized ore from the mortar boxes to cyanid vats, and which prevent the escape of the clouds of dust that have been the chief obstacle to the adoption of dry crushing in the past." Now, in dry-crushing silver mills this trouble has been met by closing in the mortars and removing the crushed ore by screw conveyor or fan in boxes or pipes, connected with an elevator if necessary.

As to the subsequent treatment of gold ores after crushing, the *Journal* remarks upon the difficulty of amalgamation. In

the method referred to the ore goes at once to cyanid vats, and treatment over plates is of course inadmissible. The *Journal* well remarks that there are classes of ore which do not lend themselves to treatment of this kind; it also dwells upon the advantages of amalgamation, either alone or as an intervening stage between the battery and the cyanid vats. It gives due weight to the difficulties of the final metallurgical methods, but says that the recent (?) successful application of the dry process marks a most useful advance. There are, of course, many other machines besides the stamp battery for dry crushing, —rolls, grinders, Chile mills, and a host of other pulverizers. It might also be observed that, though water for crushing may be dispensed with, a mill can not be run wholly without it, as there must be water for the boilers, cyanid vats, if any, and other minor purposes.

Prospecting with the Diamond Drill.

AMONG several topics touched on in "Notes on Mining," a contribution to the *School of Mines Quarterly*, Mr. Richard A. Parker makes some practical remarks on the use of the diamond drill. Too much reliance, he thinks, must not be placed on its results in prospecting metal mines, but these must be supplemented by a close study of the form and nature of the known ore bodies of the district. In coal regions the warning has not the same force, for very obvious reasons. In the first case the lenses or deposits have dips and pitches, which, together with the line and angle at which the drilling is done, should be accurately plotted. To plot the drill hole accurately, it is not sufficient to take the direction of the hole near the surface; the fact that the rods may change, and probably have changed, must be considered. A great deal of money has been spent in proving that the results of diamond drilling are at times deceptive. Confirmatory holes should always be drilled where there is the faintest possibility of being misled by the results of drilling as shown by the original cores.

In sending down water to cool the bit and borts and wash the detritus from the cutting edge and send it to the surface, a small hand pump is used, sending the water down through the hollow rods, core barrel, and core lifter. In dense rock there is no loss of water, but in broken strata it may run off. Mr. Parker explains the necessity of making the leaky seams watertight, which is done by sending down paper cartridges of bran, plaster of Paris, or hydraulic cement, which are broken by a rod let down for that purpose and the contents rammed into the crevices. After allowing this material to harden or fill the crevices, drilling is resumed.

Another useful hint brought out by the author is the necessity that the engineer in charge of an exploring party should be acquainted with the nature and peculiarities of the diamonds themselves. After describing these he adds that old stones, weighing a karat to a karat and a half, are worth far more than new ones of the same weight, because they have been tested, and also because the loss occasioned by the wear of sharp points or angles is obviated. Therefore, worn stones of suitable size are to be purchased in preference to new ones.

Canadian Nickel Mines.

ACCORDING to an article in the *Iron Age*, the mine at Sudbury, Ontario, produced more nickel last year than in any previous year. Still, the quantity does not seem large, in view of the prospective demands for new utilizations, especially in alloys. The official figures stated that 112,037 tons of ore were mined and 87,916 tons were smelted. The nickel contents of the matte produced amounted to 2570½ tons, copper 2748 tons, and cobalt 3¼ tons. The value of the nickel was $612,734. There are five companies at work on seven locations. Since 1888, when operations began, the total production of nickel has been about 10,000 tons, and of copper about the same amount. It is stated that the Canadian mine owners have not made as large profits as they expected. This has been due to unsatisfactory prices for the product. In 1876 the price was $2.60 a lb.; but it fell considerably on the open-

ing of the mines in New Caledonia, and later the prospect of a heavy output from the Sudbury mines themselves still farther reduced it, so that in 1894 the average was 86¼ cents. The cost of production is heavy, the matte produced on the spot having to be shipped to the United States or Europe for the extraction of the nickel, copper, and cobalt contents. On the other hand, all the coke used in smelting comes from Pennsylvania. A royalty of 3 per cent. on the nickel and copper was imposed in 1891. The average tenor of the Sudbury ore is not as high as that of the New Caledonia ore, which runs 5 to 6 per cent. nickel. Expectations rose to a high pitch in 1890, when 4500 tons of matte were purchased at Sudbury by the United States navy department for making nickel steel for armor, etc., and a temporary boom set in, which resulted in disappointment,—the main reason being the small percentage of nickel (2½ per cent.) used in that alloy. There are, however, other new metallurgical uses, besides the old and steady demand for nickel in plating.

The Canadian nickel region is a large one, extending from the western extremity of the north shore of Lake Huron to the boundary of the province of Quebec at Lake Abbitibbi,—a distance of over 300 miles, with a width of 75 miles; and during the nickel excitement there was much speculation in nickel-bearing lands, or those supposed to be such. The supply in the neighborhood of Sudbury is known to be immense.

Definite Combination of Alloys.

THE distinguished French engineer and metallurgist, M. H. Le Chatelier, recently read a paper on this subject before the Academie des Sciences in Paris, in which he said that, while definite alloy combinations are admitted by chemists, yet, besides brass and bronze, few particular cases are cited in the books. Further, the author holds that, of all the many combinations of metals experimented with, few are of interest from a scientific or practical point of view, because investigators have mainly directed their attention to physical rather than chemical characters and because the physical properties have given rise to somewhat contradictory conclusions.

The special alloys investigated and described by M. Le Chatelier are those of copper-tin (bronze), copper-zinc (brass), aluminum-copper, and chrome-zinc. His general conclusion as to definite combinations of metallic alloys is that they can be obtained by using an excess of the more attackable metal, and attacking the resulting alloy by an appropriate reagent. The definite alloys are hard and easily broken, and possess none of the malleable properties of the various metals of which they are built up. This appears to be the author's test of definiteness of composition; in other words, the physical properties are referred to as a proof. In the examples given the observed and the theoretical percentages are stated.

Gold-Mining Profits.

IT is of doubtful utility to attempt to compute average costs in precious-metal mining for all or even a considerable number of mines, since the results vary more widely in individual cases than in any other industry, and it is impossible to obtain the data necessary for the calculation, so that only a few particular instances can be cited, while for all only general qualified statements can be offered, and even these must be accepted with reservation. However, *Mining Industry* (Denver, July 25) editorially claims that gold mining in Colorado at the present time "pays a higher percentage of profit than any other productive enterprise in the world," and that in one case the cost of producing gold "is not to exceed 5 cents for $1." In another "a dollar costs 25 cents," and "in scores 50 per cent. or more of the product is net profit." "From the declared dividends of the incorporated gold-mining companies we know that, if they were the only ones which made profits, over 12 per cent. of the total [Colorado] gold product is profit, and, of the product of the incorporated companies only, over 31 per cent. is net profit." It is stated that only twenty-one gold-mining companies in Colorado declared profits,

while there are about 300 gold mines in that State which yielded something, more or less. This looks like a pretty substantial showing, but the *Industry* fails to say anything about the failures and idle or abandoned gold mines. All the same, it is a most creditable showing as it stands, and it is gratifying to learn that Colorado is recovering from the depression in silver mining by its intensified interest in gold mining.

Ward Gold District, Colorado.

WARD district, Boulder county, Colorado, is by no means a new camp, and on that account perhaps attracts less attention than some of its younger rivals. Gold Hill and Copper Rock, in its immediate neighborhood, and Cripple Creek and other gold-mining districts elsewhere in the Rocky mountains, have been the scene of much excitement and mining activity, while Ward has remained a quiet, though steady, producer. A correspondent of the Denver *Mining Review* describes the camp and its leading mines in the issue of that paper for June 7, with illustrations of some of the works. The gold belt is about 4 miles wide and contains four principal and parallel lodes. The ore is gold-bearing chalcopyrite and pyrite, and differs from the tellurid gold ores of near-by districts. Under present conditions this ore can be mined and treated much more cheaply than formerly, a tenor of $4 per ton being aid to pay. Still, the ore is not wholly free milling, but requires concentration after amalgamation. The principal mines on the Columbia vein are the Utica, Boston, Number 5, Columbia, Ni-Wot, Madeline, Teller, Sullivan, and DeWitt. The Ni-Wot, once a heavy producer, is still earning $200 a day, while the Utica produces $500. Altogether these mines have yielded several million dollars. Another important group is in Spring gulch. The correspondent considers the Modoc as at present the most interesting mine of the district. It lies apart from the other principal veins, and has long been worked in good, but rather refractory, ore. Its mill contains the usual crushing plant, amalgamating machines, and belt vanners, and a cyanid plant is about to be added to treat the concentrates, hitherto shipped to smelters. Other mines and mills of the district are mentioned favorably.

The Chemist and the Blast Furnace.

"THE word chemist," writes Prof. Wm. B. Phillips in the *Engineering and Mining Journal*, "is employed in its widest signification [that is, in connection with furnace work], for the educated chemist is something more than a mere analyst. . . . If iron brokers can afford to build and equip a chemical and testing laboratory and engage a competent man to take charge of it [as has lately been done], how much more does it behoove the maker of the iron to see to it that the product, as it leaves his furnace, shall be as nearly perfect as it is possible to make it?" Besides the need for chemical study of iron intended for steel making, Professor Phillips points out that there is now a tendency to demand that certain grades of non-bessemer iron shall have a definite composition, variable within certain limits, it is true, but conforming to certain specifications. "In the grading of ordinary foundry, mill, and forge iron the need for the chemist is so patent that it is needless to discuss it. With uniform stock there is uniform iron, with varying stock varying iron." These variations are often quite beyond the skill of the ordinary grader, and Professor Phillips with reason asserts that the solution of the whole matter lies with the chemist. "If need be, let him have the furnace for his laboratory and the foundryman as chief assistant, and let them work it out. In nine cases out of ten these two can arrive at the cause of the trouble, and find a remedy for it."

THE *Engineering and Mining Journal* says that a bill now before the Canadian Parliament providing for the payment of a bonus on ores smelted, will probably pass. It appropriates a sum not exceeding $30,000 per annum, for 5 years to be paid for all ore smelted, at a maximum of 50c. per ton, smelters blown previous to July 1, 1896, only to participate.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*8. The Revolution in Steel-Making. William Metcalf (Importance of the open hearth process). Eng Mag–Sept. 3000 w.

25. Tin Plate Production in this Country (Statistics, quarterly list of tin plate works in United States and list of brands of tin and terne plates made in United States). Met Work–July 6. 2000 w.

27.—$1.25. Report on the Loss of Gold in the reduction of Auriferous Veinstone in Victoria. Ill. Henry Rosales (With recommendations as to improvement, especially dressing of slimes). 65 pgs. 13″ × 8″.

30. The Micro-Metallography of Iron. Ill. Thomas Andrews (Three systems of crystallization. Temperature. Measurement of crystals). Eng & Min Jour–July 6. 1300 w.

70. Sulphate of Ammonia Production at Blast Furnaces (Record of economies at Scotch furnaces). Am Mfr & Ir Wld–July 5. 700 w.

97. Molten Metal by Railway (Steel ladles transported five miles). Sci Am Sup–July 13. 800 w.

110. Annual Mint Account (Operations of San Francisco Mint, 1894–5). From San Francisco Chronicle. Min & Sci Pr–July 6. 1100 w.

141. The Concentration of Auriferous Sulphides in California. Ill. W. H. Storms (Tailing and slimes concentrated by vanners, sizers and canvas tables). Eng & Min Jour–July 13. Serial. 1st part. 2800 w.

143. The Ropp Straight–Line Furnace. Ill. (Long reverberatory; mechanical rabbling). Eng & Min Jour–July 13. 900 w.

166. Blast Furnaces July 1, 1895 (Statistics in detail. Editorial comment). Am Mfr & Ir Wld–July 12. 600 w.

*224. Reduction of Alumina, etc., by Hydrogen (Apparatus; method). Chem Tr Jour–July 6. 300 w.

*255. Pyrometers for Measuring High Temperatures. Ed. Deny (Abstract. Describes types; mode of using). Col Guard–July 5. 2000 w.

274. Production of Pig Iron in the United States in the First Half of the Year 1895; with Editorial (Detailed statistics). Bul Ir & St Asso–July 20. 1000 w.

*324. The Electrolytic Deposition and Reduction of Copper (Some practical experiences on a commercial scale. Summary of papers by E. Jensch and E. Cohen). Elec Rev, Lond. July 12. 1400 w.

365. Charcoal Iron. R. W. Raymond (Outlook). Eng & Min Jour–July 20. 500 w.

412. The Open Hearth Plant and Plate Mill of the Illinois Steel Company. Ill. (Details; construction). Ir Age–July 25. 2400 w.

413. The Increasing Production of Pig Iron (Encouraging outlook). Ir Age–July 25. 600 w.

*414. Cyanide at Pambula (Working method). Aus Min Stand–June 15. 750 w.

*415. Barrier Sulphides (The Banfield Process). Aus Min Stand–June 15. 700 w.

433. Pig Iron Production This Year (Analysis of half-year's returns). Am Mfr & Ir Wld–July 26. 600 w.

436. Iron Making in Virginia. H. S. Fleming (Cost of producing pig iron). Mfrs' Rec–July 26. 1500 w.

*472. The Broken Hill Problem (Sulphides and their treatment). Min Jour–July 20. 6500 w.

525. The MacArthur-Forrest Patent Commission (Testimony, Mercur case). Min & Sci Pr–July 27. 1200 w.

609. The Outlook for Charcoal Iron (Editorial. Competition with coke iron). Ir Tr Rev–Aug. 1. 900 w.

614. Before Bessemer—and After (Editorial. Recent process). Ir & Coal Tr Rev–July 26. 850 w.

*634. Application of Blast Furnace Gases to Gas Engines (Draws attention to a more economical and efficient method of using the thermal energy of these gases than has hitherto been employed). Col Guard–July 26. 800 w.

*639. Critical Notes on the "Sulman" Processes of Gold Extraction. W. Bettel (Mr. Sulman uses a cyanogen-yielding substance in presence of potassic or sodic cyanide to effect solution of gold and silver, instead of atmospheric oxygen, claiming that solution of precious metals by haloid compounds of cyanogen in presence of a solution of cyanide is infinitely superior to the MacArthur-Forrest process). Aus Min Stand–July 6. 2700 w.

642. The Basic Bessemer Process. F. E. Thompson (Alleged proof that there is nothing inherent in the basic Bessemer process to prevent the making regularly of good steel of soft quality for structural and other purposes). Ir Age–Aug. 8. 2500 w.

†658. On the Study of Slags from Lead Furnaces with the Object of Producing Liquation or Crust Effects. Joseph Struthers (An important research with extensive bibliography of the subject). Sch of Mines Quar–July. 2000 w.

662.—$1.50. Notes on Manufacture and Properties of Malleable Cast-Iron. H. R. Stanford (Written for the purpose of arousing interest and evoking discussion on this important industry. Gives personal experiences and tests with tabulated results). Tr Am Soc Civ Eng–July. 5800 w.

Mining.

9. *Ontario Drain Tunnel and Electric Plant C. R. McKay. (A work of interest to electrical and mining men). Eng Mag–Sept. 3000 w.

We supply copies of these articles. See introductory.

29. The New Comstock Enterprise. Dan De Quille (Cor.—Description of Brunswick Code. Its re working). Eng & Min Jour–July 6. 1600 w.

102. Iron Prospects in Southwest Virginia (Corr. Description ; favorable outlook ; freight statistics). Ir Age–July 11. 1800 w.

109. The West Side Lode. Ill. (Prospects west of main Comstock lode). Min & Sci Pr–July 6. 1600 w.

*111. Iron Ore Mines of Elba (History ; geology ; method of working). Kuhlow's–July 3. 6900 w.

*112. Mining Explosives (Experiments with safety explosives). Kuhlow's–July 3. 600 w.

*120. Rock Drills. What Constitutes an Efficient and Durable Drill (Requirements ; use and care of power drills). Col Eng–July. 3600 w.

*121. Electrical Mining Machinery. Ill. (Hauling, pumping, and drilling plant, Mt. Lookout Colliery). Col Eng–July. 1000 w.

*122. A Mine Fire Extinguished. Ill. Baird Halberstadt (Bulkheads and partial flooding). Col Eng–July. 1500 w.

*123. Ventilation of Mines (Mathematical discussion. J. T. Beard's book). Col Eng–July. 600 w.

*124. Mining Explosives (Effect on gas and dust in collieries ; combustion products). Editorial. Col Eng–July. 800 w.

*125. The Examination of Candidates for Certificates as Mine Foreman (Answers). Col Eng–July. Serial. 1st part. 1600 w.

*126. Electric Coal-Cutting at Glencleland Colliery (Extracts from paper by George Mitchell before the Mining Institute of Scotland. Cutters; working results). Col Eng–July. 1200 w.

142. The New Mining Law of Idaho (Full text). Eng & Min Jour–July 13. 1800 w.

164. Mine Locomotives with Secondary Batteries. F. Combessedes (From Bulletin de la Société de l'Industrie Minerale. Details; working costs). Am Mfr & Ir Wld–July 12. 900 w.

213. The Great Newhouse Tunnel. Ill. (To tap Gilpin County mines ; present condition). Min Rev–July 12. 1100 w.

*218. Some Electric Mining Plant. Ill. (Colliery power plant ; hauling and hoisting engines; 3-throw pump). Eng, Lond–July 5. 900 w.

*230. The African Golconda (History's discovery). Fairplay–July 5. Serial. 1st part. 1800 w.

*244. Some Australian Minerals (Antimony, bismuth, platinum, chrome, manganese, plumbago). Ir & Coal Tr Rev–July 5. 600 w.

*246. Rio Tinto Mining Company (Commercial outlook ; iron and copper products). Editorial. Ir & Steel Tr Jour–June 29. 500 w.

*251. The Monmouthshire Coalfield. M. E. (General description ; methods of working). Col Guard–July 5. Serial. 1st part. 1500 W.

*252. Pumps and Pumping Machinery for Collieries and Mines. Ill. Philip R. Björling (Formulæ for duty ; describes lift pumps). Col Guard–July 5. Serial. 1st part. 2300 w.

*256. The Breithaupt Mining Theodolite. Ill. (Trans. from La Revue Technique. Details). Col Guard–July 5. 1800 w.

†297. The SukKur Petrololeum Borings (Failure ; geological prospecting). Ind & East Eng–June 15. 500 w.

346. Coal Deposits of Kachemak Bay, Alaska (Important discovery). Min & Sci Pr–July 13. 900 w.

*350. These Golden Nineties. D. H. Wheeler (Unexampled increase in the output of gold). Chau–Aug. 2400 w.

*361. Rent and Royalties in Leases of Mines (Legal questions; English law). Col Guard–July 12. 3200 w.

364. The Coal Fields of West Virginia. Ill. Jed Hotchkiss (Geological). Am Mfr & Ir Wld–July 19. Serial. 1st part. 3000 w.

366. The Dipping Needle and the Miner's Compass. Ill. William Allen Smith (Use in iron mining). Eng & Min Jour–July 20. 3500 w.

402. Mine Managers and Workmen (Editorial. Qualifications contrasted). Min Ind & Tr–July 18. 1000 w.

403. Two Great Mining Properties. Ill. (Hope and Katie Mines, Mont.) West Min Wld–July 20. 900 w.

419. Debris Commission's Report (Extracts). Min & Sci Pr–July 20. 700 w.

420. The Trail Creek Country. Clarence King (Important new gold and silver field). Min & Sci Pr–July 20. 1400 w.

421. The Sultepec Mining District. C. (Silver ; lead). Cor Min & Sci Pr–July 20. 1000 w.

445. Zinc and Lead Mining in Missouri and Kansas in 1895. J. R. Holibaugh (Brief review). Eng & Min Jour–July 27. 600 w.

*469. The Russian Oil-Industry (Statistics). Irm–July 20. 400 w.

*471. The Present and the Future of Coolgardie (Favorable account). Min Jour–July 20. 2600 w.

*473. The Output of the South African Republic in 1894 (Review report of the Minister of Mines). Min Jour–July 20. 1200 w.

*482. The Right to Work Mines to the Injury of the Surface (Litigation in England). Col Guard–July 19. 2500 w.

*484. The Timsbury Colliery Explosion (Gas ignited by shot). Col Guard–July 19. 4300 w.

*485. A Pass-Bye in a North Wales Mining Shaft. Ill. W. H. Wilson (Two cages in one compartment). Col Guard–July 19. 800 w.

*486. The Prevention of Colliery Explosions in Austria. Robert Lamprecht (Precautions in blasting and lighting). Col Guard–July 19. 1200 w.

*490. Improvements in Water-Spraying Apparatus for Coal Mines. Ill. (Abstract of paper by W. Saint, Manchester Geol. Soc). Ind & Ir–July 19. 600 w.

499. The Mesaba Range (Commercial character of ores ; sampling ; mining costs). Ir Age–Aug. 1. Serial. 1st part. 3800 w.

510. Production of Iron Ore in the United

States in 1894 (Advance statistics of the United States Geological Survey). Bul Ir & St Asso–Aug. 1. 1500 w.

524. Metalliferous Deposits in Fissures. Melville Atwood (Theory of vein formation). Min & Sci Pr–July 27. 2800 w.

529. The Possible Revival of Virginia City, Nevada. L. P. G. (Geological outlook.) Ill. Sci Am Sup–Aug 3. 1400 w.

*550. The Proximate Analysis of Coal. S. W. Parr (Apparatus and method for simple tests). Am Eng & R R Jour–Aug. 1000 w.

*561. Ellangowan Colliery. Ill. George B. Hadesty (Seams worked; system; surface plant). Col Eng–Aug. 3800 w.

*562. The Luke Fidler Mine Fire. Ill. Baird Halberstadt (Slushing with culm and water; tunnel and shaft dams). Col Eng–Aug. 2800 w.

*564. Modes of Working Coal. J B. Hanford (Paper read at Meeting of Mining Inst. of W. Cent. Penna). Col Eng–Aug. 500 w.

*565. A Lecture on Mining. W. N. Atkinson (Accidents; training of mining engineers). Col Eng–Aug. 2000 w.

*566. A Novel Steel Tipple. Ill. (Convenient arrangement; Forest Hill Mine, Penna). Col Eng–Aug. 600 w.

579. Transvaal Gold Mines in 1895 (Statistics; increased production). Eng & Min Jour–Aug. 3. 1000 w.

580. The Fourmile Placer Fields of Colorado and Wyoming. Ill. E. P. Snow (Geological; technical). Eng & Min Jour–Aug. 3. 2000 w.

581. An Experiment in Coöperative Mining. D. W. Brunton (Lease System at Aspen). Eng & Min Jour–Aug. 3. 1200 w.

†583. The Geological Survey of New South Wales (Abstract of colonial report). Ind Engng–July 6. 1300 w.

†585. Gold Mines in Victoria. H. (Abstract of colonial report). Ind Engng–July 6. 1000 w.

587. Electricity in Coal Mining. Ill. (Plant at Mount Lookout Colliery). Tradesman–Aug. 1. 1800 w.

603. I. The Outlook for Canadian Phosphates. Editorial. II. Phosphate's Future. Robert C. Adams. III. Phosphoric Acid in Agriculture. Frank T. Schutt (Problem of marketing low grade rock). Can Min Rev–July. 10500 w.

604. The Use of Electrical Apparatus in Mining. W. F. Dean (Power transmission; hoists; pumps; haulage; drills). Can Min Rev–July. 3000 w.

605. Canadian Phosphate and Fertilizers. J. Burley Smith (Home manufacture and home market). Can Min Rev–July. 5000 w.

610. Gold Mining in Georgia. F. W. H. (Reprint from Southern Cultivator; early history). Min Rev–Aug 2. 1300 w.

*612. Mining in Spain. From report of C. S. Smith (Iron and coal). Ir & Coal Tr Rev–July 26. 1400 w.

*613. Some Observations on the Western Part of the South Wales Coalfield. Thomas Arnold (Abstract of paper presented to the South Wales Inst. of Min. Eng. Geological). Ir & Coal Tr Rev–July 26. 2500 w.

*633. Firedamp and Coaldust in Austrian Mines. From report of R. Lamprecht. (Means adopted for the prevention of explosions in Austro-Hungarian mines). Col Guard–July 26. 800 w.

636. Alabama Gold Discoveries. H. S. Fleming (Investigation by expert). Mfrs Rec–Aug 2. 400 w.

*640. Victorian Gold Mining. Thomas Cornish (A description of the Dunolly gold field, one of the most important in Australia). Min Jour–July 27. 1500 w.

†656. System of "Long Wall" Used in Northern Illinois Coal Mines. Ill. G. S. Rice (Description and discussion). Sch of Mines Quar—July. 3000 w.

Miscellany.

*245. The Exports of Iron and Steel from the United States. Editorial (Increase; competition). Ir & Coal Tr Rev–July 5. 1000 w.

*254. Occurrence and Mode of Working Petroleum in Lower Alsace. L. Van Werveke (Abstract of paper read before Fed. Inst. of Min. Eng. Geological and technical). Col Guard–July 5. 2700 w.

347. Fluming Ore in Alaska. N. S. Trowbridge (Economy of transport; mine and mill). Min & Sci Pr–July 13. 700 w.

362. Pig Iron Production and Business. (Editorial. Statistics; prices). Age of St–July 20. 1000 w.

443. The Montana Mining Law. (With comments by R. W. Raymond). Eng & Min Jour–July 27. 4800 w.

453. Platinum in Alaska (Reported discovery). Bos Jour Com–July 27. 400 w.

*470. The Economic Importance of the Murchison Range. The Gold in the Conglomerate (Geologic). Min Jour–July 20. 4400 w.

*487. Coal and Iron in Spain (Statistical). Col Guard–July 19. 1800 w.

*563. The Proposed Amendment to the British Mining Law (New sections criticised). Col Eng–Aug. 2500 w.

*635. The Coalfields of the United States (Descriptive and statistical). Col Guard–July 26. 1600 w.

*638. The Superficial Alteration of Ore Deposits. R. A. F. Penrose, Jr. (Treats of both mechanical and chemical courses of superficial alteration which extend to a depth of hundreds of feet). Aus Min Stand–June 22. 2600 w.

*641. Slate Quarrying. Editorial (Business opportunities in New South Wales). Min Jour–July 27. 1300 w.

†653. Segregation in Ores and Mattes. David H. Browne (Theory of origin of Sudbury nickel-ore deposits, with appended note by J. F. Kemp). Sch of Mines Quar–July. 3000 w.

MUNICIPAL ENGINEERING

Water-Supply for Tall Buildings.

THE department of public works of the city of New York has very properly declined to supply to the tall buildings now erected and in process of erection water under pressure sufficient to carry it to the upper stories. If the upper stories are to be supplied, the owners of such buildings will be required to pump it up there for themselves. The city will supply the water, but not the pressure. In explanation of this position, Gen. Collis, deputy commissioner of public works, made in the New York *Sun* of July 15 a statement, of which the following is an abstract:

"The problem which confronts us is one of distribution, not of supply; and even this, though serious, is in no way alarming. The present average daily consumption is a little less than 200,000,000 gallons; yet the supply on hand in the several storage and other reservoirs is 18,000,000,000 of gallons. In other words, we have 90 days' supply on hand.

"The increase in daily consumption during the past 5 years has been 25,000,000, so that in 1900 we will be using 250,000,000 a day, by which time the dams at Carmel and Amawalk will be completed, giving us a volume of 17,000,000,000 additional gallons, making a total of 35,000,000,000. Five years later at the furthest, the great dam at Cornell will be finished, increasing the supply by 25,000,000,000, making a grand total of 60,000,000,000 gallons of pure water, well protected against contamination, to furnish a demand of, at the utmost, 400,000,000 a day. And back of all this are the waters of Lakes George and Champlain, and the vast acres of Adirondack lakes. Perhaps this is going far enough into the future, and yet Lake Erie is left to us,—one of those great fresh-water seas which God created for some wiser purpose than navigation. After that the deluge."

Gen. Collis admits, however, that the system of distribution is unsatisfactory, but claims that it is receiving the attention it deserves. As to the pressure clamored for, by some,—a pressure that would force water to the fifteenth or twentieth story,—he thinks that owners of lower buildings who put in their plumbing before tall buildings were erected have some rights which are entitled to consideration.

"The pressure necessary to force water to the top of the tall buildings now being erected would play havoc with the plumbing of the buildings down town which were erected a quarter of a century ago, for water will refuse to climb until it has exhausted every other effort to escape.

"Surely the people who are thus in jeopardy are entitled to some consideration. The plumbing referred to was gaged, when new, to resist a pressure of 40 lbs. to the square inch. The present down-town pressure is 15 lbs. in day-time and 25 lbs. at night. Increase it 10 or 15 lbs., which might carry it to an elevation of 75 ft. at Wall street, and something would have to give way. If an announcement was made to-day that the pressure would be increased to 40, or even 35 lbs., on the 1st of January next, all the plumbers in New York could not get the hotels, office-buildings, apartment-houses, and tenement-houses, and the homes of small consumers in condition to meet the change. It would be a great season for plumbers, but how the landlords would howl!"

"Those who have erected buildings on the outskirts of the city, where, as yet, no water mains have been laid, and then, in the *rôle* of ill-used taxpayers, demand that water-mains shall be laid immediately to meet a want which they have anticipated perhaps by several years . . . . have only themselves to blame. They are at liberty to procure water from the nearest source," but Gen. Collis warns the public that the time is approaching when restrictions will be enforced as to the time in the day that pumping can be allowed, in order to prevent interference with supply in denser portions

of the city. It is asserted that 25 per cent. of the water-distribution of the city goes to waste, which seems to us an underestimate. It is also asserted that the law requiring meters to be located in every building except those used exclusively for dwellings is evaded.

A valuable suggestion relating to fire-protection for tall buildings is of general application. "The problem of fire protection for the vertical growth of the city in high buildings which are looming up at different points and frequently in isolated localities is a separate question. They must not expect to be provided for, so far as pressure is concerned. A separate circulation for high pressure for their special protection would be so costly as to be prohibitive; therefore the reasonable way to dispose of this matter belongs to the owners themselves, and to the water-lifting and throwing apparatus of the fire department,—*viz.*, portable water towers and steam fire engines. So long as the city pipes are sufficient to supply these engines with reasonable pressure—say 20 to 30 lbs. to the square inch—protection for these high buildings is provided for, and the city does its part. The owners of such buildings might now speedily protect themselves by having pipes placed on the outside of their buildings, to which the fire-engine hose could be attached. These would answer the purpose of a high portable tower for each building and its neighborhood, the pipes remaining empty save in the case of fire. Provided with this simple fire stand pipe on each high building, the pumping power located within, or in a neighboring building if the burning building was not available, could be so connected as to supplement the fire department apparatus. Thus the city's responsibility would lie in furnishing the requisite quantity of water, instead of the excess of pressure, and in so equalizing the distribution that at any and all times sudden demands would be met."

A danger which, it is to be hoped, is remote, but which might be at some time calamitous, is incurred by all "salt-water cities,"—New York especially.

"Here are two million of souls absolutely dependent upon a base of supply nearly 40 miles distant from the field of consumption, the line of communication being an aqueduct, sufficiently well guarded perhaps in time of peace, but, in case of war or insurrection, more tempting to an enemy than a poorly-defended harbor. Lake cities and those built upon the banks of inland rivers are in no such jeopardy, but the protection of the water-supply of all sea-coast cities is, in my opinion, as grave a question for the consideration of the national government as the construction of harbor defenses or navies."

Scientific Filtration.

THE purification of sewage has progressed so rapidly of late and on such distinctly scientific lines as to justify the above title of an editorial in *The Engineer* (July 12). This editorial deals with a report recently made by Mr. Dibdin, chemist of the London county council, upon elaborate and carefully-conducted experiments instituted for the purpose of ascertaining the best methods of filtering the sewage effluent at the northern outfall precipitation works. Two series of experiments were carried out. The significance and importance of the results will be apparent from the following quotation.

"In the first series of experiments the filters were built of wood, and were four in number, each equal in area to the two-hundredth part of an acre. The operations commenced as far back as June, 1892, and by the month of August in that year it was found that the degree of purification effected by coke breeze exceeded that obtained with any other material, the comparison being made with burnt ballast, sand, pea ballast, and a proprietary article combined with sand. The reduction in the amount of oxidizable organic matter in solution was 62.2 per cent. in the case of the coke breeze, the nearest approach to this result being that afforded by the use of the proprietary article in combination with sand, the reduction in that case being 61.6 per cent. Burnt ballast went no further than 43.3 per cent., and was the lowest on the list. The proprietary filter is said to have excelled the coke breeze so

far as concerned the degree of improvement effected in the appearance of the filtrate, but, while the actual purification fell a little short, the cost was such as to be prohibitory. The conditions of success among the various filters were found to consist in porosity, and the consequent power of re-absorbing atmospheric oxygen. For foul waters sand proved too fine, and burnt ballast too coarse. Numerous gelatine plate cultivations were made, and it was discovered that the greater or less number of micro organisms present afforded no indication of the degree of purification effected. As a rule, the microbes were more numerous in the filtrates than in the tank effluent before filtration. Whether the microbes were few or many, the object aimed at was the attainment of the highest degree of speed consistent with such purification as would remove all objection in respect to odor and liability to putrefaction.

"So much being learned, a second series of experiments was entered upon, in which each filter covered exactly 1 acre of land. The first result was to clog the coke breeze filter with sludge, and to render it putrid throughout in less than 3 months. It was thus shown that rest and aeration were vital. A more cautious and gradual mode of proceeding, in which the filter was merely filled and emptied twice daily, secured the necessary biological conditions, and produced satisfactory results. About 500,000 gallons of effluent passed through the filter daily, and the purification ranged between 70 and 80 per cent. After a full month's working the purification reached 83 per cent., and fish placed in the filtrate were kept alive for many weeks. The daily quantity of effluent was afterwards increased to over 600,000 gallons, the analytical results being still highly satisfactory. At last the filter was made to pass an average of 1,000,000 gallons per day, including all times of rest, and for 8 weeks the filtrates were clean and sweet, the purification effected being 78 per cent. 'Nitrification proceeded satisfactorily,' says the report, 'and the filter was apparently capable of continuing for an indefinite time.' Great importance naturally attaches to the fact that the filter worked efficiently during the extraordinary frost which occurred in the early part of the present year. The experiments, taken as a whole, are considered to show that sewage, especially if previously clarified by precipitation, 'may be purified to any desired degree.' The actual amount of purification depends on the length of time during which the effluent is allowed to remain in contact with the filter, and the length of time allowed for aeration. If a reduction of 75 per cent. in the oxidizable organic matters in solution is considered sufficient, the quantity that can be treated daily on 1 acre of coke breeze is 1,000,000 gallons."

Glasgow Hydraulic Power Supply.

NOTWITHSTANDING the intense opposition which increase of municipal control of the supply of public necessities has met, it appears that a gradual extension of such control is in progress. One of the latest examples is the supply of hydraulic power in Glasgow for the elevators and presses of that city, which is interesting from both engineering and economic points of view. In this enterprise Glasgow has followed the lead of Hull and London. *The Engineer* (July 19), in a general description of the Glasgow plant, says that "works were laid down in Hull in 1874, and in 1882, 1883, and 1884 works were established in London, where they have proved to be of great public utility. In London there are 75 miles of mains, with a pressure of 750 lbs. on the square inch. The number of machines working from these mains is twenty-three hundred, bringing in a revenue of £50,000. In these circumstances it was not to be expected that the 'second city' of the empire would long remain without the immense facilities which hydraulic power —for special purposes undoubtedly supreme—confers upon large commercial and industrial communities.

"Originally a private company intimated its intention of supplying the needs of the city of Glasgow, represented mainly by some six hundred hoists and hydraulic presses scattered over the city's area, but they relinquished the project when the

water commissioners of the corporation made it known that they themselves had resolved to enter upon the undertaking. This ended the matter so far as private enterprise was concerned, as it was clearly realized that none but a very strong commercial company could have carried out the scheme to a satisfactory issue. Independently of the main items of cost—the site, the buildings, the machinery pipes, and work—there was the question of wayleave for pipes through the streets. The city's authorities have always strictly conserved their rights and privileges in this connection, and would not lightly have given any company permission to open up the 10 miles of thoroughfare through which the pipes extended."

In the design of this plant provision has been made for a large increase in the use of water pressure over present needs, and the present instalment is only sufficient for half the full capacity. The water is furnished at a pressure of 1120 lbs. per square inch, to supply which, in the present stage of development, four large Lancashire boilers with economizers, and three sets of pumping-engines, are used, each of the latter pumping 230 gals. of water per minute against the accumulator pressure named. Steam pressure of 120 lbs. is supplied to the engines. The water is pumped into a huge iron tank,—capacity, 200,000 gals. The latter is made of ¾-in. and ⅝-in. plates of the best quality, which were subjected to the severest tests before use.

"The accumulators, two in number, have rams 18 in. in diameter, with a 23-ft. stroke. The cylinders are cast in one length, and the rams are also each of one piece of cast metal turned. The engines work independently, each one delivering into one of the four 7-in. main pipes. While the pressure on these is supplied from the accumulators, they have been so arranged that, should necessity arise, the pressure on the delivery mains can be supplied from one accumulator. The four main pipes have been laid throughout the district of supply in such a way that they form two separate circuits,—one circuit to the north of Argyle street—the grand artery running east and west in Glasgow—and the other to the south. At certain points there are cross connecting pipes with valves, which will enable the system to be worked as one or two separate circuits. There is a further provision against stoppage of the whole hydraulic supply through fault at any particular place. Connected with the 7-in. delivery mains, there are in the chief streets 6-in. and 5-in. pipes. All of these are provided with valves, enabling any street to be cut off from the general circuit, should this be necessary."

Huge Water Supply for London.

THE *Sanitary Record* (Aug. 2), gives a general popular description of the new scheme of water supply for London. There is now felt the imperative necessity for an increased supply, and it is asserted that the water at present supplied is too impure to be fit for domestic consumption. Altogether, the people of London are sadly incommoded both by insufficient supply and the character of the water they are compelled to use.

The recent Royal Commission on the water supply came to the conclusion that the supply of water required for the metropolis was likely to increase from 171,000,000 gallons to 415,250,000 gallons daily in 1931, thus more than doubling the quantity at present provided. During the course of that investigation the water companies submitted that an additional supply of 300,000,000 gallons could be obtained from the river Thames, this supposition being based upon the assumption that the latter could be treated in a manner similar to the Lea—that is, that nearly all the water could, without harm be abstracted from it. Further investigations which have been carried out since the date of the Royal Commission have, however, proved that this quantity, having regard to the general welfare of the metropolis, cannot with safety be taken from the river. They have also demonstrated that the purity anticipated by the Royal Commission can hardly be expected to continue in the future with the present increasing population of over 1,000,000 persons in the Thames Valley, as the investigations have shown that the ex-

isting filter beds are unable to cope with the discolored flood water which comes down the Thames, and which is always charged with large amounts of bacterial life.

The urgency of the matter is illustrated by the fact that the gathering grounds are gradually being appropriated by other towns, as for instance Manchester at Thirlmere, Liverpool at Lake Vyrnwy, Birmingham in Wales, and other towns elsewhere. But where is London to seek for an ample supply? The engineer to the County Council, Mr. A. R. Binnie, has been making inquiries outside the metropolis as to supplementary sources of supply, and the result is the preparation of the most gigantic water supply scheme yet elaborated.

This enormous scheme, the carrying out of which would involve a capital expenditure of £38,000,000, is based upon the utilization and conveyance to the metropolis of water from South Wales. There are five main sources of supply—the valley of the Usk, Yrfon, the Edw, the river Ithon, and the upper portions of the Wye proper. The geological formation of the ground and the contour of the valleys lend themselves admirably for the easy erection of large reservoirs, and the supply is estimated at 415,000,000 gallons a day.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

72. The Enriching Value of Benzole and Acetylene. F. L. Slocum (Shows causes of variation in tests of benzole, and makes a general comparison of its enriching value with that of acetylene). Am Mfr & Ir Wld–July 5. 1600 w.

159. Some Improvements in the Methods of Manufacturing Sulphate of Ammonia. C. Stafford Ellery (Extracts). Pro Age–July 15. 600 w.

168. Acetylene as an Enricher. E. G. Love (Supplementary to a paper read by the author before the Society of Gas Lighting. Comprises a diagram and tables of candle power of various gaseous mixtures. The most hopeful outlook for acetylene is its use *per se* in small gas burners). Am Gas Lgt Jour–July 15. 800 w.

169. The Production of Cyanides. From paper of M. G. Perthius (Products rich enough in cyanides to be profitable produced in gas manufacture. Chemical reactions and process described). Am Gas Lgt Jour–July 15. 1000 w.

*219. Thwaite's Power-Gas Plant. Ill. (Describes a plant for manufacturing motor gas by the Thwaite continuous cycle process, or non-reversal process, in which the hydrocarbons are actually burnt in one vessel and recarbonized in a second vessel, and by which the difficulties in using bituminous coal are removed). Eng, Lond–July 5. 2300 w.

*313. Incandescent Gas Lighting. S. M. Highlands (Competition of electric lighting and the Welsbach system). Gas Wld–July 13. 1700 w.

456. Notes on Cyanogen in the Manufacture of Illuminating Gas. M. G. Perthius (In view of the increased attention now directed to the production of cyanides in gas manufacture, this is a very important paper. The subject is thoroughly treated. Translated from the French by Hermann Poole). Am Gas Lgt Jour–July 29. 4000 w.

*497. Chemico-Technical Investigations at the Technical College of Carlsruhe. H. Bunte (Abstract translation of preliminary report on work now in progress at Carlsruhe Technical College on products of combustion of gas flames, tests of incandescent burners and carburetting). Jour Gas Lgt–July 23. 2800 w.

528. The New York and East River Gas Company's New Holder. Ill. (Descriptive). Pro Age–Aug. 1. 1400 w.

596. Welsh Anthracite Coal. John L. Howard (States most recent and accepted theories of the formation of bituminous coal, composition of many varieties, and qualities essential for production of illuminating gas). Am Gas Lgt Jour–Aug. 5. 7000 w.

597. Technical Gas Analysis. J. Bryant Grimwood (Modern rapid methods). Am Gas Lgt Jour–Aug. 5. 3700 w.

598. The Economy of Small Works. John Clements (Practical management; discussion). Am Gas Lgt Jour–Aug. 5. 3000 w.

*630 The Glasgow Gas Works. Ill. (Descriptive). Engng, Lond–July 26. Serial. 1st part. 2400 w.

*667. Notes on the Chemical Constitution of Illuminating Gas in Relation to Its Illuminating Value, and on Some of the Physico-Chemical Conditions which Influence the Luminosity of Gas-Flames. W. Young, with Discussion. Jour Gas Lgt–July 30. 13500 w.

Sewerage.

†17. The Sewerage of Bradford, England. Claude Meeker (Report from an official source of a system wherein sewage and rainfall flow into the same sewer). San–July. 1500 w.

238. Ventilation of Separate Systems of Sew-

erage. Parker N. Black (Considers the presence and character of gases in sewerage systems, advocates ventilation of sewers, but independently of house drains). Eng Rec-July 13. Serial. 1st part. 1300 w.

*359. Scientific Filtration (Editorial. Discusses the experiments made by the Main Drainage Committee of the London County Council). Eng, Lond-July 12. 1200 w.

*397. The Chemical Constitution of Gas Enrichers, and Its Relations to Their Enriching Value. Wilfrid Irwin (A paper read before the Manchester section of the Society of Chemical Industry, with discussion. A very thorough examination of the subject with illustrations of gas flames as affected by enrichment). Jour Gas Lgt-July 16. 5800 w.

*606. York Sewerage Works (Brief description). Ind & Ir-July 26. 600 w.

Streets and Pavements.

409. The Wear of Brick Paving at Johnstown, Pa. (Table of Records). Eng News-July 18. 600 w.

*418. Street Subways for Large Towns. Charles Mason (Abstract of paper read at a recent meeting of the Soc. of Eng). Gas Eng Mag-July 10. 2000 w.

*542. Natural Rock Asphalt Paving in Europe. Ill. W. H. Delano (General description of the system and the method and plant for manufacturing the blocks). Paving-Aug. 1200 w.

*543. Brick Paving Specifications in Leading Cities (Abstracts of specifications of various leading cities where best work has been done). Paving-Aug. 2300 w.

589. How to Make a Good Paving Brick. J. W. Penfield (Criticism of article by T. Townsley. Brick-Aug. 2000 w.

Water Supply.

46. New York City's Water Supply (Editorial deploring low pressure). Fire & Water-July 6. 500 w.

47. Some of the Difficulties and Advantages that Have Arisen by the Use of Meters in a Southern City. Fred Crosby (Paper read at Atlanta Convention of Am. Water Wks. Asso. Ambiguous city ordinances. Contests with consumers). Fire & Water-July 6. Serial. 1st part. 2600 w.

48. Electrolysis Threatens Brooklyn's Water Mains. George W. Plympton and Fred R. Lee (Effective protection by conductors). Fire & Water-July 6. 600 w.

226. New York's Water Supply. Ill. (Review of James C. Duane's report to the Aqueduct Commission. Work done on the Croton Aqueduct, 1887 to 1895). Fire & Water-July 13. 1000 w.

237. The Water-Works of Asiatic Constantinople. Ill. (Reservoir; dam; filters). Eng Rec-July 13. 1100 w.

340. The Jerome Park Reservoir. Ill. (Construction; capacity). R R Gaz-July 19. 1000 w.

455. The New Water Supply for Waterbury, Conn. (Abstract of lecture by R. A. Cairns, before students of Rensselaer Polytechnic Inst). Eng Rec-July 27. 5000 w.

*477. Glasgow Hydraulic Power Supply (Account of the municipal supply of water for hydraulic elevators in Glasgow, Scotland. Water supplied at 1120 lbs. pressure per sq. in). Eng, Lond-July 19 2000 w.

*632. Craigmaddie Reservoir for Glasgow Water Supply. Ill. (Record of details. Problems of novel character). Engng, Lond-July 26. 3600 w.

651. An Enclosed and Wind-Braced Standpipe, St. Charles, Mo. Ill. Edward Flad (Descriptive). Eng News-Aug. 8. 1800 w.

663.—$1.50. The Water-Works of Syracuse, N. Y. William R. Hill, with Discussion. Ill. (Description of works and their erection). Tr Am Soc Civ Eng-July. 13000 w.

*670. Huge Water Supply Scheme for London (Outline description). San Rec-Aug. 2. 900 w.

Miscellany.

*7. Surveying and Mapping a City. C. H. Rice. (The great importance of accurate work). Eng Mag-Sept. 2800 w.

*178. Calorific Value of Refuse (Account of Mr. Naylor's experiments and their results, with tables,—and use of refuse in steam generation). Elec Eng, Lond-July 5. 3000 w.

*241. The Growth of Sanitary Engineering During the Past Twenty-one Years. H. Percy Boulnois (From an English standpoint). San Rec-July 5. 3200 w.

*243. The Efficiency of the Refuse Destruction (Abstract of Paper read before Asso. Mun. & Co. Eng. at Halifax. Record of Royton Experiments; refuse burning). Ir & Coal Tr Rev-July 5. 1000 w.

*569. The Clearing of Mulberry Bend (The story of the rise and fall of a typical New York slum). Ill. Jacob A. Riis. Rev of Rev-Aug. 4500 w.

572. Philadelphia's Fire Bureau. Ill. (Abstract of report of R. A. M. Beilter, Head of Dept. of Public Safety, describing recent improvements in the city's fire bureau). Fire & Water-Aug 3. 600 w.

*576. Cleveland Conference for Good City Government. Clinton Rogers Woodruff (The conference a distinct success). Am Mag of Civ-Aug. 1800 w.

*578. The Health of London (Statistics and comments from Report of the London County Council's Medical Officer). Nature-July 25. 1800 w.

*666. Gas Flames and Luminosity (Editorial review of a paper read by Mr. Wilfrid Irwin before the Manchester Section of the Chemical Society). Jour Gas Lgt-July 30. 2300 w.

†684. The Proper Diameter of Fire-Hose. Ill. B. L. Stowe (Regarding the effect of different sizes upon the wearing qualities). Ind Rub Wld-Aug. 10. 1100 w.

We supply copies of these articles. See introductory.

RAILROADING

Track for Heavy Locomotives.

IN the *Engineering News* for July 25 there appears an article without signature on "Track for Heavy Locomotives," containing many interesting data. After commenting upon the comparative lightness of the track of many American railways which use very heavy locomotives, it states that the conditions of safety and maintenance vary according to the nature of the road and traffic, as a light track which would be safe on straight and level line, where the trains run easily, might be dangerous and expensive on a line with sharp curves and steep grades, over which the engines work very heavily. On the other hand, a well-laid and maintained track may give better service than a relatively heavier track with low joints, worn ties, and loose ballast. Referring to an article that appeared in the issue for May 9, in which the dimensions of several of the enormously heavy engines were given, it now gives, in connection with these, data in regard to the tracks over which these engines are running. They are as follows:

Railway.	Type.	Total wt. in lbs.	Wt. per Driver lbs.	Rail lbs. per yd.	Max. grade
Southern Pac.....	12 wheel	173,500	18,313	76	2.2%
Dul. & Iron R'ge.	"	169,000	17,375	60,80	
Great Northern	"	156 000	17,000	80	
Bur. & M. River..	Decapod	150,300	15,030	56,66,75	3%
C'nwall & Leb....	Consol.	150,000	16,875	60	1.7%
Del. Sus. & S.....	Mogul	151,500	22,650	60	

Mr. R. Augst, chief engineer of the Duluth & Iron Range Railroad, is quoted as stating that the twelve-wheel engines were too heavy for the original track, which consisted of 60-lb. rails spliced by 24-in. angle bars and four bolts, and having 110 linear in. of tie face per 30 ft. rail. In 1888 renewals were begun giving 125 in. per rail-bearing tie surface. Trials are now being made with ties 7 in. thick. The above is for 60-lb. rails on new work, but on the old track 80-lb. rails are used spliced with 23-in. Sampson angle bars and home-made base plates at the joints. The ballast is gravel of various degrees of coarseness. While there are twice as many consolidation engines with 103,000 lbs. on a driving-wheel base of 14 ft. 1 in. as there are twelve-wheel engines with 138,000 lbs. on a driving-wheel base of 15 ft. 6 in., there is a decided increase in wear and tear and in the number of low spots in the track, as well as much shortening of life in the bridges built before 1892 or since renewed, but the proportion of this increase due to the twelve-wheel engines cannot be estimated with any degree of certainty.

This road is rapidly reinforcing its bridges, and is increasing the tie-bearing of the rails as fast as the track is renewed. Mr. Augst states that he is satisfied that in a short time the cost of maintenance with 80-lb. rails and twelve-wheel engines will not exceed that for the 60-lb. rails and consolidation engines, and he is not prepared to advocate a heavier rail for any purposes of economy.

The preparation for an increased weight on driving wheels has led to a reduction in cost of maintenance with the lighter engines, and has enabled still heavier engines to be used with very little extra expense for reinforcing track and bridges. The effect of the heavier driving-wheel loads of the twelve-wheel engines is apparently in a vertical direction, disturbing the surface of the track, as there is no noticeable increase in the nosing motion of the engines and incidental widening of the gage.

Mr. John F. Stevens, chief engineer of the Great Northern Railway, says that the track upon which the heaviest engines run consists of 80-lb. rails, spliced with 36-in. angle-bars, weighing 30¼ lbs. each, and six bolts. There are sixteen ties to a rail length, and the ballast is mainly coarse gravel. He says there is no special extra cost for maintenance where these heavy engines are used.

Mr. Weeks, in speaking of the tracks of

the Burlington & Missouri River Railroad, says that the rails of 56, 66, and 75 lbs. have eighteen ties to the rail length, with cinder or gravel ballast. The joints are spliced with four-bolt angle bars on the lighter rails and six-bolt bars on the 75-lb. rails,—the bars extending over three ties. The decapod engine running over the 56-lb. rail caused no more apparent wear than a consolidation engine, and he believes that, when run at low speed (12 to 15 miles per hour), they can be run on less substantial track than is required for class H mogul engines at 45 to 60 miles per hour. No extra maintenance of track is required where these decapod engines are used.

Mr. John McDonell of the Cornwall & Lebanon Railroad states that the consolidation engines weighing 150,000 lbs. in use on that road work very easily, and the 60-lb. rail is considered perfectly safe. He thinks, however, that a 60-lb. rail with sixteen ties to the rail is too light to be economical with engines with wheel loads as large as 16,875, and this opinion is confirmed by the experience of the Duluth & Iron Range Railroad.

The Delaware, Susquehanna & Schuylkill Railroad has ten mogul engines weighing 151,500 lbs. with 135,900 lbs. on a driving-wheel base of 14 ft. The track consists of 60-lb. rails carried by fifteen ties to the rail length. Ballast, cinder. Mr. Kudlich reports that with one and a half men per mile the track can be repaired and kept in perfect condition.

Compound Locomotives.

A RUNNING discussion upon this subject at one of the noon sessions of the recent master mechanics' convention (*Railway Age*, July 5) indicates the estimation in which the compound locomotive system is now held in the United States. Much practical experience with compound locomotives was recounted, and the general consensus of opinion was decidedly favorable to the system.

Mr. Garstang reported a saving of 22.9 per cent. in fuel by the use of a compound locomotive as compared with that of 59-in. simple, ten-wheel locomotives used on the same road, and stated that the cost of maintenance of the compound locomotive was less than that of the simple. Mr. Gibles said that he was "convinced that the compound is the coming locomotive for freight service, and that it behooves us to help this advancement all we can. We will make some mistakes in the compound; you may say it is an easy matter to stick on another cylinder, and therefore it should not be much of an experiment. It is a radical change, however; it changes the steam distribution, valve motion, etc. The compound engine offers the most universal means of accomplishing a fuel economy of 15 per cent. We have had one compound for 4 or 5 years; we ascertained the economy on an elaborate test of the engine, and it is still showing that economy. I find from a record of 2 years' performance there has been spent an average of about 2½ cents a hundred miles for repairs as against 4.7 cents for the other engines of the same class,—about $1000 a year less. It is easy to make 10 per cent. difference in the coal economy, saving $500 a year in fuel."

Mr. Barnes warned against the use of too many automatic devices, and advocated independent exhaust. He alleged that extravagant reports of the economy of compound engines had been promulgated. "In a paper read before the American Society of Mechanical Engineers 18½ lbs. of steam per horse-power hour, was claimed. Another man claimed 17½, but he did not give all the facts. He measured his 17½ lbs. from the indicator card, while the engine itself showed probably 24,—quite another matter. Some discoveries relative to indicator cards, resulting from tests on compound engines, have been made. We find that with a long pipe you can make an engine show 1000 h. p. when she has only 800 h. p. The compound locomotive started out in this country with one low-pressure piston, weighing 800 lbs. The builders have been forced to go to a light piston. If there is any difficulty in the way of the further introduction of the compound locomotive, it is in the matter of the reciprocating parts. Railroad superintendents are becoming exercised by the damage to track not accounted for by

the passing of loaded cars over the track. It comes from locomotives, and because of excess balance; and for high speeds, where the wheels are not very large, it may be we will have to stick to simple engines for that reason alone. In England the compound has been abandoned, while in Germany and other countries, where the railroads are under the control of the government, and haul their trains more ecenomically, the compound is on the increase. One of the causes of reported failures of compounds is to be found in the fact that they are not always adapted for the work they are called upon to do."

Mr. Vauclain said: "The building of compound locomotives is not attended with good luck at all times. You have a certain amount of grief mixed in with the joy that comes to you, and you have got to put up with it. It is the grief which prompts you to do the work. The use of compound locomotives has given to railroad companies in the United States a means of reducing their operating expenses to a greater extent than any other item of improvement connected with the operation of locomotives. We have had several examples lately of how energetically the companies proceed in the methods of saving oil. If the railroad companies would proceed as energetically in the direction of perfecting the compound in saving fuel, the amount saved would have a greater bearing upon the cost of operating their locomotives. If we turn to Europe, where they have been using compound locomotives for a much longer period than we have, we will find that, on the whole, compounds are making great headway."

In the course of further remarks the speaker added that "for high-speed service the single expansion engine is needed to a certain point. After that point is reached, you must get back to compound cylinders in order to increase the efficiency of your boiler, and get advantage of the 15 or 20 per cent. you are able to save in the consumption of water. When you operate a compound locomotive up to its maximum efficiency, evaporating 65 gallons of water a minute, if single expansions were applied to the same engine, it would be impossible to make the speed."

Mr. Mitchell gave his experience with light Baldwin compounds. "They have been in service for 2 years, on fast and slow trains,—mostly fast freight trains,—and giving excellent results. They save from 8 to 10 per cent. in coal and about 15 per cent. in water. The water is more important, as the incrustation of the water with us is very great; with the simple type we only get 8 or 10 months' service out of the flues; with the compound, 12 to 14 months'."

Mr. Herr thought that a considerable saving of coal could be effected by the use of the compound locomotive, "especially in freight service." Mr. Davis thought that the compound locomotive was the locomotive of the future, but that the progress would be more rapid if the advocates of the compound were more moderate in their claims.

Manual Interlocking.

THE early stages in the evolution of methods of train-handling are traced by Mr. George H. Paine in an entertaining paper on "Certain Interesting Features in the Manual Interlocking of Railroads (*Proceedings of the Engineers' Club of Philadelphia*). The first step he considers to have been brought about by an effort to reduce the cost of handling trains, and consisted simply in stationing men permanently at certain switches, so that they might be opened without having to stop trains. "From this one fact all interlocking probably took its rise, for it was soon discovered that one man could take care of a great many switches, if he could only get to them; so somebody proposed taking the switches to the man, which was done forthwith." In the meantime "somebody else suggested that, if an engineman could, through a signal, know something about how he was going to find a switch a little before he reached it, time and money would be saved, since he would not then be always required to come nearly to a stop in approaching switches in obscure locations or else run the chance of a disaster. It was evident at

this point that the man who controlled the switches must also control the signals. In this way the operating mechanism of both signals and switches came to be placed side by side." The idea of interlocking is credited by Mr. Paine to English railroad men, and "it must also be recorded, to our shame, that the use of interlocking had reached a highly-developed state in England before even a start had been made in this country."

The aims of interlocking are, first, to decrease dangers; second, to facilitate and therefore reduce the cost of handling trains. Mr. Paine here remarks that fortunately the two usually go hand in hand, for in the management of trains that plan which will result in an ultimate economy is likely to prove the safest.

While the theory of interlocking is perfectly simple, the practice is most complicated, especially where there are a large number of levers in a machine. Not only may a certain arrangement of tracks be interlocked in several different ways, but, a certain scheme having been decided on, the several combinations which result may be secured by a widely different arrangement of locks. The locking is performed by the shifting of "dogs," the series of dogs connected with one lever being moved in such a way as to either prevent or permit the movement of all the other levers concerned in that combination. The dogs are mounted on locking bars, which in turn are fastened, through the medium of a small shaft and a link, to the latch of the lever. By this arrangement all of the necessary levers are locked fast before any movement takes place in the lever to be thrown; and none of those levers which have been locked, but are to be unlocked, are released until the lever in action has reached its new position and is latched there. Furthermore, no change in the locking takes place during the movement of the lever itself. The technical expression given by Mr. Paine for this essential feature of all good locking is "preliminary."

Next to the machine itself, the most interesting features of the system are the signals, the selectors, the facing-point locks, the detector bars, and the compensators,—the object of which arrangements is to make it absolutely certain that the proper signal will be cleared, that every switch over which a train must pass will be set and locked in the correct position, and that every signal which controls a conflicting movement will be locked in the danger position. Many of the mechanical devices employed for the purpose are shown in the diagrams accompanying Mr. Paine's able essay.

Color of Semaphores.

IN the discussion which followed the reading of Mr. Paine's paper, it was stated that in England yellow semaphore arms are quite frequently used, because that color can be seen better. The author did not consider it better than red, if the proper shade of red is used and the blade kept properly cleaned and frequently painted; and he said that the advantage of the yellow is that it has no significance in signals at all. Dr. H. Leffmann remarked that yellow has been considered by some authorities as the most brilliant color to the human eye, but added that whether it would be suitable for semaphores would depend on the landscape. Standing out against the blue sky, it would probably be more conspicuous than any other color. This was qualified by the observation that yellow blades against a background of plowed fields, etc., could scarcely be distinguished. Dr. Leffmann also thought that it was perhaps a mistake that color was ever employed. To be able to judge the signals by their position only, he believed, would be an advantage. Whether this statement was meant to apply to all signals is not quite clear.

Electric Motors for Railways.

EXCEPTION is taken by the *Railroad Gazette* (August 9) to the construction placed by the daily press upon the recently-announced arrangement between a great electrical manufacturing company and an equally great locomotive-building works for the supply of certain parts of the same machine by each works. As a matter of fact, the newspapers did have some rather

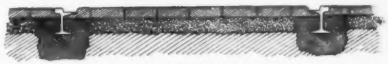
extreme "scare heads," such as "an industrial combine," "a combination of millions," "big industries in alliance," "great companies unite," and so on. The *Gazette* explains that "the simple fact is that these two companies have made an arrangement under which they will unite in developing electric motors suitable for railroad work. The resources of both establishments will be utilized in design, experiment, and determination of standards in general and in detail. Further than that, orders which may be secured for engines of this description will be divided, each works doing that part for which it is fitted by plant, skill, and experience." The *Gazette* goes on to say that "it is an obvious waste of energy for the electric works to build frames, running gear, and all that part of motors and electric locomotives which the locomotive works are especially qualified to to, and which they are likely to do a great deal better than any one, however skilful, coming new into the field. On the other hand, it would be an obvious waste of energy for locomotive works to put in additional plant and the additional staff necessary to make the strictly electrical equipment for such machines. Therefore, combinations such as have been made between the Baldwin and Westinghouse companies are in the direction of economy of energy, and for the interest of the parties immediately concerned, and of the great public."

The New York *Times* (August 10), commenting on the foregoing, again lays stress on the importance and meaning of the arrangement, and, after referring to the few existing ventures into the realm of heavy electric railroad work (the Nantasket Beach road, the powerful electric motors of the Baltimore & Ohio, and those on one short branch of the Pennsylvania system), presents a well-considered discussion of that much-mooted question,—how far electric haulage is to encroach on steam in railroading. A favorable, though conservative, view is taken.

Track Construction Without Ties.

THIS might seem almost an absurdity, but such a track has been laid on 1½ to 2 miles of a street railway in Detroit, and has been tried so long that it can hardly be considered a novelty. The system is briefly described in the *Street Railway Review*, from which the accompanying cut is copied.

The rail is laid without ties by making trenches 1 ft. wide, and deep enough to allow 6 in. of concrete to be put under



TRACK WITHOUT TIES.

each rail. Tie rods are put in every 10 ft., but these are not "ties" in the usual sense. A 7-in. girder rail is used. This system of construction is claimed to be suitable to streets which are permanently paved before the tracks are laid. The pavement most suitable is asphalt or brick, as this class allows the concrete to come much nearer the top of the rail than pavements with deep blocks. A similar method of construction has been employed in Montreal and Toronto for 2 years, and is said to have given good satisfaction. It is a radical departure from all established methods.

A Railway Race in Great Britain.

A NOTABLE speed competition has been inaugurated between the companies using the east and west coast routes from London to Scotland, this time the objective point being Aberdeen, instead of Edinburgh and Glasgow as in the famous struggle of 1887. *Engineering*, of August 2, contains a carefully-prepared analysis of the situation, and gives the history of the remarkable accelerations in speed attained by the competing lines. It must be remembered that the times given are on regular daily schedule, and not exceptional single runs. As to the question whether such racing is advantageous to the public, and what its value is to the engineering profession and to shareholders, *Engineering* makes some pertinent remarks. For one thing, each company has its prestige to maintain; otherwise public support is withdrawn. To the possible suggestion that amalgamation of the competitors would result in economy, *Engi-*

neering answers that the British public has a most steady inclination in favor of competitive railroads. "Moreover," it adds, "progress requires such competition." Again, as is shown by a graphic chart, permanent acceleration follows such contests. At the same time, economy in working becomes, with keener competition, a necessity, so that ingenuity towards this is stimulated. On these grounds, *Engineering* concludes, there is a measure of permanent good, even to the shareholders, which cannot accurately be measured. That racing is advantageous to the general public our authority believes to be undoubted—and it might have added invidiously here that the solid construction of British roadbeds and careful precautions against accident allow the extreme powers of the engine to be put forth without additional danger.

In the great contest of 1887 the time between London and Edinburgh was cut down in a few weeks—by successive shortenings of from half an hour to a few minutes, first on one line, then on the other—by 2 hours in all, on a journey of 400 miles, which meant a gain of 20 per cent. and a regular schedule rate of 54 miles per hour, including all stops and notwithstanding grades. As a matter of fact, the final achievement was an average speed, including stoppages, of from 56 to 58 miles an hour. But, as *Engineering* observes, the achievements of to-day are the commonplace performances of to-morrow, and the extreme 1887 speed—7 hours 27 minutes from London to Edinburgh—has been lately matched by a regular timetable rate of 7 hours 30 minutes.

At present the main contest is on the London-Aberdeen runs, 540 miles by the west coast and 523 miles by the east,—much longer and more difficult runs than the run to Edinburgh. On August 1 the trains were running the whole distance, including stops, at the following average speeds: west coast, 52.8 miles; east coast, 49 miles; while on the preceding day a train on the London and North-western and Caledonian lines had made the brilliant record of 54.09 miles, through average, which *Engineering* pronounces to be unparalleled in Great Britain for a run of 540 miles with such gradients. The trains, it is true, are comparatively light. Those on the Aberdeen service now consist of six to eleven 8-wheel bogie carriages,—train weight 130 to 175 long tons.

The First Inside Locomotive.

G. A. SEKON in *The Railway World* for June finds this question is variously answered, and there is still a doubt in some minds as to whether priority should be awarded to Edward Bury, Robert Stephenson, or Timothy Hackworth. The "Liverpool," built by Bury, the "Planet," built by Stephenson, and the "Globe," built by "Hackworth," were all constructed in 1830. All three were inside cylinder machines, but who is entitled to the credit of the idea? Yet, with two exceptions, the standard authorities award the honor to Bury; and Mr. Sekon cites a long list of proofs to establish the truth of this conclusion. Among these is a statement made by Peter Lecount, a well-known railway official, and a personal friend and fellow officer with Bury on the London and Birmingham Railway, who says: "The first engine made by Bury was the 'Dreadnought,' which started on the Liverpool and Manchester Railway March 12th, 1830. The next was the 'Liverpool.' This was the original engine made by him, with horizontal cyclinders and cranked axles. She was placed upon the Liverpool and Manchester Railway on July 22d, 1830, and had an 18-in. stroke, 12-in. cylinders, and two pairs of 6-ft. coupled wheels." Lecount goes on to describe the first eight engines built by Stephenson for the Liverpool and Manchester Railway, of which he writes: "They had the cylinders outside the boiler, and worked by a crank pin on the wheel. Mr. Bury's engine, the 'Liverpool,' was then constructed for that railway, and about four months after it had been placed upon the line Mr. Stephenson adopted the crank axle and placed the cylinders horizontally, with the improvement of putting them inside the smokebox. This was done first to his engine, the 'Planet,' which was placed upon the railway Oct. 4, 1830,"—three months' priority.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*5. The Modern Problem of Grade Crossing. Ill. William O. Webber (Experience and practice in New England). Eng Mag–Sept. 3000 w.

26. Brake Shoe Material. Editorial (Comparison of brake shoe material on basis of wear, frictional quality and price). Ry Mas Mech–July. 800 w.

43. Principles vs. Precedents (Editorial. Business side of transportation). Ry Rev–July 6. 800 w.

55. The Electric Systems of the North and West Chicago Street Railroad Companies. Ill. Edward M. Hager (Descriptive of track construction, electrical construction, power houses and car equipment). W Elec–July 6. 5200 w.

56. The Nantasket Electric Road. Ill. (Details of construction and equipment of an advanced example of suburban electric railway). Elec Rev–July 3. 2500 w.

57. The Substitution of Electricity for Steam in Railway Practice. Inaugural Address by Dr. Louis Duncan, A. I. E. E., Niagara Falls, June, 1895 (Able discussion of respective limitations of steam and electric transportation). Elec Rev–July 3. 5000 w.

58. Tests of a Combined Electric Light and Electric Railway Central Station. Ill. Dugald C. Jackson and Arthur W. Richter (Paper read before the A. S. M. E., Detroit, June, 1895). Elec Rev–July 3. 3400 w.

*61. Railway Companies' Savings Banks. C. H. G. (Detailed information about this institution and others of like character). Bank Mag, Lond–July. 1300 w.

65. The Baltimore Belt Line Tunnel. Ill. (A description of the tunnel and the electric power station which furnishes current for the big electric locomotives). Elec Rev–July 10. 2500 w.

73. New Wabash Shops of the C., C., C. & St. L. Ill. (Descriptive). R R Gaz–July 5. 1000 w.

74. Electricity on the Railroads (Editorial. Conservative estimate of competition). R R Gaz–July 5. 1300 w.

76. The Tehuantepec Railroad—Its importance as a Competitor for Transcontinental Traffic (Corr. Present condition, outlook and advantages). Ry Age–July 5. 2800 w.

77. Compound Locomotives—Experience of Experts (Free discussion at the recent Master Mechanics Association. Generally favorable to the compound system). Ry Age–July 5. 1900 w.

78. Report on Air Brake Tests by Committee of Master Car Builders Association. Ry Age–July 5. 2000 w.

83. Freight Traffic on Electric Railways. Ill. (Special traffic examples; combination cars; market cars; mail service). Eng News–July 11. 2000 w.

87. Freight Stations and Yards on English Railways. Abstract of Report by George H. Turner. Ill. (Arrangement; system of handling). Eng News–July 11. 5000 w.

95. The Intercontinental Railway Commission. E. Z. Steever (Secretary's Report. Conference of 1889; organization; projects). Sci Am Sup–July 13. 2500 w.

112. The Terminal Improvements at Providence. Ill. (Site; bridges; station). R R Gaz–July 12. 2500 w.

113. Concord and Montreal 8-Wheel Passenger Locomotive. Ill. (Dimensions; weights). R R Gaz–July 12. 350 w.

114. Mr. Aspinall on Express Locomotives. (Review and abstract of paper read at Internation Railroad Congress, with editorial. Types for high speed; simple and compound engines; slide valve; permanent way). R R Gaz–July 12. 2800 w.

115. Car and Train Loading. Condensed paper by M. W. Mansfield (Mathematical formulæ). R R Gaz–July 12. 1100 w.

116. American and English Locomotives in Japan (Comparative tests). R R Gaz–July 12. 900 w.

117. Track Laid in the United States to July 1 (Detailed statistics). R R Gaz–July 12. 1000 w.

118. The Physical Condition of Railroads (Editorial. Need of fuller reports). R R Gaz–July 12. 600 w.

119. Railroad Organization (Abstract reports of International Railroad Congress). R R Gaz–July 12. Serial. 1st part. 2000 w.

154. Railway Receiverships and Foreclosures in 1895 (Editorial. Statistics; comments). Ry Age–July 12. 900 w.

155. The Electric Problem (Steam roads using auxiliary electric power). Ry Age–July 12. 400 w.

156. Transcontinental Railways in Mexico and Central America. Map (Proposed routes; distances). Ry Age–July 12. 1600 w.

160. Sixty-foot Rails (Favorable tests). Ry Rev–July 13. 400 w.

161. The South Indian Railway. Ill. Clement F. Street (Shops; Engines; cars). Ry Rev–July 13. 800 w.

162. The Staff System. A. H. Rudd (Block System for intervolved bridge tracks). Ry Rev–July 13. 400 w.

163. Does It Pay for Railways to Operate Their Own Brass Foundries. Discussion (Arguments pro and con; limitations). Ry Rev–July 13. 1000 w.

*175. The Effect of Temperature on the Strength of Railway Axles. Thomas Andrews (High and low temperature; axles, tires, rails). Engng–July 5. 2500 w.

*176. Rolling Stock for Express Trains. Abstract. C. A. Park (American, English and other types; construction; details). Engng–July 5. 6200 w.

182. Special Track Work for Electric Street Railways, Especially Referring to the Montreal and Toronto Systems. Ill. E. A. Stone (Goes extensively into details from, and including the general survey, to the shop work and the track laying). Can Elec News–July. 5000 w.

*217. The International Railway Congress (Editorial comment on discussion of papers). Eng, Lond–July 5. 5000 w.

*223. Electric Traction. Ill. Full abstract of paper by M. Auvert (Classification and description of type systems). Eng, Lond–July 5. Serial. 1st part. 5800 w.

227. Niagara Falls River Railroad. Ill. (Trolley, water and steam power). Fire & Water–July 13. 700 w.

*248. The International Railway Congress (Discussions; strengthening permanent way; signaling; fast freight; light railways; decimal and metric accounting). Trans–July 5. 7000 w.

*249. The American Interstate Commerce Commission (Summary and comments on report). Trans–July 5. 1000 w.

*260. Electric Track Drill at South Chicago. Ill. (Time-saving). St Ry Rev–July 15. 500 w.

*261. Iron Clad Cars. Ill. J. W. Greer (Construction; advantages). St Ry Rev–July 15. 1200 w.

*262. The Lenox Avenue Conduit Road, New York. Ill. (Underground trolley; details). St Ry Rev–July 15. 1500 w.

*265. A Run on a French Compound Express Engine. Ill. A. M. B. (Reversing gear; firing; speed; signals; 2 decked cars). Ry Wld–July. 1600 w.

*266. Havre Electric Tramways. Ill. Also Editorial (Line; power station; rolling stock). Ry Wld–July. 800 w.

*267. The Central London Railway. Ill. (Projected underground electric line, route; financial). Ry Wld–July. 900 w.

268. Revision of the Rules of Interchange, with Editorial (Changes in new M. C. B. rules). R R Car Jour–July. 2800 w.

269. Statistics of the Railroads of the United States for Year Ending June 30, 1894 (From Interstate Commerce Commission Report). R R Car Jour–July. 250 w.

270. Anatomy of a Freight Car. Ill. (Plate showing 143 principal parts). R R Car Jour–July. 1500 w.

271. The Per Diem System and the Movement of Cars in Interchange (Correspondent's criticism of report of Car Service Committee, Am. Ry. Asso). R R Car Jour–July. 1700 w.

272. Reports Presented to the Master Car Builder's Convention (With discussion on interchange of cars; mounting new and second hand wheels; air-brake apparatus and tests; brake-shoe road tests; laboratory tests; lubrications of cars; coal-car sides; passenger platforms). R R Car Jour–July. 50500 w.

278. The Problems of Electric Railway Work. Oscar T. Crosby (Abstract of interview published in New Orleans Times Democrat. Frequency of service the real test). Elec Eng–July 17. 2000 w.

*292. The Trolley and the Death Roll. Townsend Wolcott (The immediate cause, or causes, and the remedy). Elec Pow–July. 2800 w.

†298. The Coming Railways of India and Their Prospects. Abstract. J. W. Parry. Ind & East Eng–June 15. Serial. 1st part. 1000 w.

345. Metallic Railway Ties. Ill. (Different styles; sections). Ry Rev–July 20. 2000 w.

348. New Jersey Electric Railway Company. Ill. (Describes power house and line). Elec Ry Gaz–July 20. Serial. 1st part. 1000 w.

356. Permanent Way. William Hunt (Abstract of report on the strengthening of permanent way with a view to the increased speed of trains. Details. English system). Engng, Lond–July 12. Serial. 1st part. 5000 w.

*357. Railway Congress—Signals (English block system. Résumé of Mr. Thompson's report). Eng, Lond–July 12. 1600 w.

*358. Very Light Railways on the Continent (Narrow gauge). Eng, Lond–July 12. 1700 w.

*363. The International Railway Congress (Col. Haines interviewed. Contrasted systems). Trans–July 12. 5500 w.

367. From Daily Report of the Illinois Central Railroad. Ry Age–July 19. 200 w.

368. Car and Train Loading. M. W. Mansfield (Mathematical analysis). Ry Age–July 19. 2000 w.

*388. Railway Communication between Europe and India (Suggested routes). Bd of Tr Jour–July. 1100 w.

408. Reversing Locomotives in Emergency Stops (Tests). Eng News–July 18. 1200 w.

*422. Experiments on the Lubrication of Bearings Made on the Paris-Lyons-Mediterranean Railway. Mech Wld–July 19. 1200 w.

426. Track for Heavy Locomotives (Safety; maintenance; details). Eng News–July 25. 1200 w.

432. Iron and Steel Railway Ties (Conflicting opinions). Am Mfr & Ir Wld–July 26. 800 w.

437. The Commercial Efficiency of Heavy Locomotives (Comparative results on So. Pac. R. R). R R Gaz–July 26. 1700 w.

440. Developing of Automatic Signaling in the United States (Abstract of paper by A. W. Sullivan, read at Int. Ry. Con). Ry Rev–July 27. 1000 w.

442. Reversing Locomotives in Emergency Shops (Conclusions from experimental tests—with editorial). Ry Rev–July 27. 1200 w.

446. Street Railway Statistics (Criticism of statistics). Ry Age–July 26. 700 w.

447. The Miller Interlocking and Block Signal System. Ill. (Automatic danger or clear signals in cab). Ry Age–July 26. 1100 w.

*455. The Railways of India (Statistics). Trans–July 19. 1900 w.

*476. History of the Metropolitan Railway. Ill. (Problems of gauge, rolling stock, brakes). Eng, Lond–July 19. Serial. 1st part. 3700 w.

*478. Some Remarkable Performances by British Locomotives. Charles Rous-Marten (Actual service records). Eng, Lond–July 19. Serial. 1st part. 4500 w.

*481. The New Underground Railway in Glasgow (Tunnel construction; walls, roof). Engng–July 19. 3800 w.

†520. Railway Construction on the Peruvian Andes. James R. Maxwell (Local conditions; historical; steep gradients. Discussion). Pro Eng Club of Phila–July. 4800 w.

†522. Certain Interesting Features in the Manual Interlocking of Railroads. Ill. George H. Paine (Evolution; mechanical details; signals). Pro Eng Club of Phila–July. 5500 w.

†523. The Philadelphia and Reading Coal Storage Plants. Ill. William D. Beatty (Level-floor system; chain conveyors; portable boom conveyors). Pro Eng Club of Phila–July. 5500 w.

†532. The New Jersey Electric Railway Company. Ill. (Track; overhead construction; power stations; car houses; rolling stock). St Ry Jour–Aug. 4400 w.

†533. Gauging Wheels and Wheel Gauges. (Design of gauge for car wheels). St Ry Jour–Aug. 700 w.

†534. Important Suggestions Regarding Wheels. Ill. (Effect of chilling; street car and motor wheels). St Ry Jour–Aug. 2400 w.

†535. Causes for Removal of Wheels. (Proportions; different defects; street car wheels). St Ry Jour–Aug. 500 w.

†536. Motor Car Wheel Mileage. W. E. S. (Record of different makes). St Ry Jour–Aug. 1500 w.

†537. Purchase and Care of Street Car Bodies. George B. Hendrick (Practical hints). St Ry Jour–Aug. 900 w.

†541. The Central London Railway. Ill. Alex. McCallum (Deep tunnel electric road). St Ry Jour–Aug. 2000 w.

*547. The Tehuantepec Railroad (Its importance as a competitor for transcontinental traffic). Am Eng & R R Jour–Aug. 2300 w.

*549. Wrecking Car—Central Vermont Railroad. Ill. (Framing; boom derrick). Am Eng & R R Jour–Aug. 700 w.

553. Louisville, New Albany & Chicago Ry. Co.'s Lafayette, Ind., Shops. Ill. (General arrangement; construction; details). Eng News–Aug. 1. 1700 w.

556. The Renewing of Worn Steel Rails (Plant and method of re-rolling and trimming). R R Gaz–Aug. 2. 1300 w.

558. Needed Reforms in Handling Freight Cars (Extracts from address of L. F. Loree, at Car Service Managers' Convention). R R Gaz–Aug. 2. 1100 w.

559. The Shay Locomotive. Ill. (Dimensions; elevation; tender sections). R R Gaz–Aug. 2. 550 w.

560. The Railroads of the World (Statistics by countries). R R Gaz–Aug. 2. 350 w.

582. The Policy of Railroad Consolidation. Letter from Mr. Samuel Spencer in reply to Transportation Committee, with editorial comment). Ry Age–Aug. 2. 2200 w.

†584. The New Overland Route Across Arabia. Ill. A. F. (Comments on article in Contemporary Review; assured future). Ind Engng–July 6. 1600 w.

*608. American and English Locomotives in Japan (Comparative dimensions; coal consumption). Ind & Ir–July 26. 1000 w.

*611. The Development of China and Japan (Railroads; gauge; bridges; tunnels). Ir & Coal Tr Rev–July 26. 2200 w.

615. Time Required to Stop Trains by the Air Brake (Graphic chart from tests). Am Mach–Aug. 1. 900 w.

617. Master Car and Locomotive Painters' Convention (Queries on painting and cleaning). Ry Rev–Aug. 3. 1300 w.

618. New Philadelphia and Reading Passenger Locomotive. Ill. (Compound; new features). Ry Rev–Aug. 3. 400 w.

619. Automatic Block Signaling with Reference to European Requirements. F. A. Delano, with Editorial Comments (Paper presented before the International Railway Congress). Ry Rev–Aug. 3. 2200 w.

626. Electrical Equipment of the Mount Holly Branch of the Pennsylvania Railroad. Ill. (Descriptive). Elec Rev–Aug. 7. 1000 w.

637. New Electric Railway. Statement of A. D. Anderson (A projected air line from Washington northward to Gettysburg). Mfrs Rec–Aug. 2. 1500 w.

647. Baltimore and Ohio Railroad Tunnel at Baltimore. Ill. (Descriptive). Sci Am Sup–Aug. 10. 4000 w.

650. Recent Progress in Railway Signaling. A. M. Thompson (Paper presented before the International Railway Congress). Eng News–Aug. 8. 2500 w.

652. New Types of English Locomotives. Ill. (Details of dimensions, etc). Eng News–Aug. 8. 1000 w.

668. Street Railway Company Cannot Use Competitors Tracks Without Express Authority (Decision in the suit of chancery in Chicago). W Elec–Aug. 10. 1000 w.

*675. Rate Cutting on American Railways (A chat with Mr. Chauncey Depew). Trans–Aug. 2. 1400 w.

677. Lead for Locomotives. C. H. Quereau (It is the opinion of the writer that a proper adjustment of lead will slightly improve the coal record, but that its chief advantage is a saving in repairs and time lost by engine failures). R R Gaz–Aug. 9. 2800 w.

678. The Reading's Single-Driver Express Locomotive. Ill. (What the engine has done and why. Description and dimensions). R R Gaz–Aug. 9. 1800 w.

680. A Failing Case in Station Design (Editorial consideration of error in design of the larger stations of the United States). R R Gaz–Aug. 9. 3300 w.

SCIENTIFIC MISCELLANY

An Innovation in Printing.

THE *Home Journal*, one of the oldest of American weekly literary newspapers, in its issue of Aug. 7 discusses an innovation in printing which was initiated about a year ago by *Liberty*, a paper which is devoted to the dissemination of the principles of Philosophic Anarchy, and which, however anyone may be disposed to dissent from its teachings, is edited with care and skill that must command the respect of all competent critics. The innovation alluded to is the abolition of a convention in printing technically called "justification." To "justify" lines in printing when setting the type is to make the lines of type all of the same length. It is a convention, pure and simple, and applies only to prose composition. The compositor, when he approaches the end of a line of type and finds that he cannot insert another complete word or syllable, takes out spaces from between the words already set and substitutes thicker spaces (spaces are strips of metal shorter than, but of the same width as, the types) until the line is made of the same length as that of the lines previously composed. This operation requires care and taste, and in high-class work consumes, as computed by *The Home Journal*, two-sevenths of the entire time required for the composition; that is to say, if a printer can set in a given time five thousand "ems" when required to "justify" the lines, he could, without "justifying," set seven thousand "ems." The time consumed in justifying is, according to this computation, two-fifths of that required for the actual type-setting, or 40 per cent. We have not verified this statement, said to have been based on actual experiment, but it appears entirely probable, and may, we think, be accepted as fact. A further computation shows that this percentage of needless work represents in the civilized world "the productive power of the labor of two hundred thousand people."

"Supposing that in the entire world there are six hundred thousand people engaged in type-setting (probably a conservative estimate), the amount of work which they now perform could be performed, by the new method, by a little more than four hundred thousand people. From this, one of two things would result: either the remaining two hundred thousand would engage in other pursuits and add to the world's wealth in that way, or else, the price of printing falling, the demand for it would so increase as to keep the entire six hundred thousand at work, thus increasing the world's literary product by nearly 50 per cent. The prices of books and periodicals would fall materially, and the opportunities for education would be correspondingly increased.

"This typographical reform would also work to the advantage of the people by enabling them to get the benefit of the type-setting machine without paying the inventor a monopoly price for it. If the machine effects a saving of 50 per cent. in comparison with ordinary hand composition, the inventor, while his patent runs, will allow 5 per cent. to the people and keep 45 per cent. to himself. But, if the people are in a position to say to the inventor that, instead of accepting his 5 per cent., they can save 30 per cent. by adopting the new method, he will immediately offer them 35 per cent., keeping only 15 per cent. for himself. Probably in the rough work of the daily newspaper, where alone as yet the machine plays an important part, the new method would save only 15 instead of 30 per cent., since the daily press takes less care to secure accurate 'justification'; this fact, however, does not affect the validity of the above argument. The inventor in that case would offer 20 per cent. to the people and keep 30 per cent. for himself. In this connection it is well to note that the supposed necessity of 'justification' has been the chief obstacle in the way of machine composition. The machine that

'justifies' automatically is of very recent date. But machines were invented long ago that would set type without 'justification,' so that, were it not for the reverence in which we hold a straight edge, hand composition would now be a thing of the remote past."

The fact is that the custom of "justification" in prose printing rests upon no rational foundation whatever. In printing blank verse lines are not justified, but, if we sought reasons for the custom, we could find as many for "justifying" blank verse as for prose. As to the appearance of a page printed without "justification," we have only to open a copy of Shakspere or Milton to find it and compare the pages with those of an ordinary prose book. We shall, on making such comparison, probably wonder at the persistence of the practice of "justification," for we certainly shall find no hint of its necessity. As a matter of fact, it is utterly arbitrary and useless.

How columns in a newspaper would appear without "justification" any one who has access to a copy of *Liberty* can see, as that paper does not "justify" its lines. An example of the effect is also given in *The Home Journal* article. Beyond the slight impression of oddity which is felt at first, as when one puts on a new hat, there is no feeling of anything incongruous or inartistic. If a page or column were really more artistic or beautiful with lines "justified," that would be a sufficient reason for perpetuating the custom; but some of the most beautiful books in existence are volumes of blank verse,—a fact which proves the contrary.

It is, however, admitted, in the conclusion of the argument, that the change advocated is not an easy one to bring about. "No journal, unless it be one which especially appeals to friends of innovation, could adopt this new method of typography without subjecting itself to a degree of ostracism which no commercial enterprise finds it expedient or safe to incur."

To the North Pole in a Balloon.

THE mere fact announced in *Nature* (July 4) that M. Andree, a Swedish engineer, has proposed to reach the North Pole in a balloon is, of itself, not important, as such a proposal is not unprecedented. The fact worthy of note in connection with the project is that the details of the proposed attempt have been so carefully considered from the practical side by a man accustomed to meet and overcome difficulties as to command the attention of one of the most learned and scientific societies in Europe,—the Royal Society of Sciences at Stockholm. *Nature* states that M. Andree has had "much experience in polar regions, having spent the winter of 1882-83 in the far north, and also taken part in the Swedish meteorological expedition, which lasted a year. He has also proved himself to be a dauntless aeronaut, his most interesting voyage being one from Gothenburg to the Isle of Gothland, in which he had to cross part of the Baltic. Everything in connection with this proposed expedition has been minutely studied and discussed, and infinite pains have been taken to solve all difficulties.

"The balloon would require a double outer covering, and a volume of 6500 cu. yds. The ascensional power thus obtained would be sufficiently great to carry three persons, furnished with provisions for 4 months, besides allowing for the car being fitted up with necessary instruments for observation, life-buoys, and Berton's collapsible boats. The car could be suspended in such a way as to allow of instant detachment in case of a descent into the sea. The entire weight of balloon must not exceed about 3 tons. In the instance of Henri Giffard's captive balloon, exhibited in 1878, and which weighed about 6 tons, it only required newly inflating after a year's use. According to Graham's observations, a balloon measuring 8¼ yds. in diameter can be made sufficiently air-tight to suffer, per month, merely a loss of 13½ lbs. of its ascensional force. M. Andree, however, hopes to produce an absolutely impermeable covering.

"The balloon, being protected from the wind by a wooden enclosure, would be inflated as far north as possible, by means of hydrogen compressed in cylinders. This

once accomplished, it would begin to ascend. To a certain extent it might be steered by means of a sail and several guide-ropes, which, dragging on the earth, forms, as it were, a brake. The ropes, however, would have to be of special composition in order to produce the same effect in water. The hindrance thus caused to the flight of the balloon, together with the pressure of the wind, would allow the use of a sail. The flight then might be an angle of 40° away from the wind direction. This steering apparatus, invented by M. Andree, has often been used by him in his aerial voyages.

"Besides the guide-ropes, heavy lines, on which would be placed numbered metal plates, would be attached to the car; these would serve as ballast. In case of a lowering of temperature and a consequent descent of the balloon, it could be lightened by throwing off these plates, which, if found, would, to a certain extent, show the course taken by the explorers."

July is named as the proper month for starting, and Spitzengen as the point of departure. A clear day should be selected, when a clear southerly wind is blowing. At this point such a wind has a mean velocity of 10½ yds. per second; but the proposed guide ropes would reduce the velocity of the balloon to 7½ yds. per second, at which rate it is computable that, if the balloon makes a reasonably straight course, the pole would be reached in 43 hours from the time of starting. At the mid-summer season it is stated that the temperature at Cape Thorsden ranges from 8° C. to 11° C.; that there are practically, no storms; and that only very light snowfalls come in June and July. It is further stated by *Nature*, which draws upon *Revue Scientifique* for the details, that the project has been approved by some of the most experienced Arctic explorers. How, after reaching the pole, the return is to be accomplished is not stated.

The Charlottenburg Mechanical Testing Stations.

THE *Physikalisch-Technische Reichsanstatt* is the euphonious German name of a testing station at Charlottenburg, near Berlin, which *Engineering* (July 19) says "is to a certain extent the realization of Professor O. Lodge's desideratum of a national laboratory." This testing station is said to be "popular amongst the manufacturers and purchasers of technical apparatus and articles, because they can have the articles tested by competent and impartial men at moderate charges. And it is held in high esteem by men of science, because there experiments can be carried on which may require a lifetime, the coöperation of several investigators, and the continued use of costly apparatus. An official testing station is now to be found in every larger German town, in connection with its university or technical college. Some towns can boast of more than one technical college, and of more than one testing station. Thus Charlottenburg and Berlin possess, in addition to the Reichsanstatt, where Professor Fr. Kohlrausch has succeeded the great Helmholtz as president, and besides other institutions of this class, the Machanisch Technische Versuchs-Anstatt, which has for some time been directed by Professor A. Martens.

"This last institution is divided into four departments, each with its chief, all of which appear to be amply supplied with the requisite machinery and apparatus. The last department is devoted to the testing of metals, ropes, belts, and also wood. The test-pieces, which are not generally received of exact dimensions, can be prepared in the laboratories, their various strengths ascertained; they can be punched, planed, crushed, welded, cast, alloyed, etched in acid baths, microscopically examined, and photographed, and polished sections or slices tested in reflected and transmitted light. For these latter purposes a micro-photographic apparatus has been designed and constructed by Professor Martens and Mr. Carl Zeiss, of Jena. Special arrangements have been made for long-continued and repeated bendings, stretchings, &c., of discs, wires, and cables. In some tests specimens of over 50 ft. length and 30 in. width can be dealt with; polished surfaces can be made

in areas of several square feet. In the second department building materials are examined,—natural and artificial stones, glass, wood, roof felting (a kind of paper is used in Germany as such), lime, cement, mortars, plasters, and drain-pipes. There are appliances for continued heating and freezing, treating in the wet, and other means of imitating the effects of ordinary wear and tear. The question of cement testing has long been recognized as one of public interest in Germany, and for some years this mechanical testing station at Charlottenburg has been acknowledged as the final arbitration court of the government. For a complete cement test 2 tons of the material are required; weights of less than 20 lbs. are not accepted even for ordinary experiments. The third department, shortly known as the paper department, inquires into paper, cardboard, canvas, tarpaulin, threads, and textile fibres in general. It is particularly requested that the specimens of paper should be packed between thick covers of cardboard, in order to avoid creases and the pressure of the postal mark. The fourth department deals with lubricants; Professor Martens is an authority on such matters.

"All these testing stations are under the superintendence of a government board. Pamphlets are issued, stating the way in which specimens should be selected, handled, packed, &c. They also give a summary of the various tests in use, and the charges made for these. The Charlottenburg list of tests comprises 419 numbers. Clients have to say, when submitting their specimens, what they wish to be done. If in doubt about the best way in which to obtain their aims, they are advised to communicate with the director. By request, experiments are conducted on the special lines desired; the certificate issued in such a case contains a notification to this effect. Prepayment is the general rule. For investigations which will occupy a long time a deposit is demanded, and a discount, varying from 10 to 20 per cent., allowed. The same facilities are offered to firms which frequently consult the testing station. The chemical laboratory in the Invalidenstrasse, Berlin, which is connected with the Mining Academy of Berlin, makes a specialty of ink and fuel testing, besides undertaking general analyses, more particularly of inorganic substances. Since 1889 the supervising board of the Prussian testing stations has published 'Mittheilungen' on the work done and experience gained. These journals contain valuable information, and the apparatus originated in these laboratories can be freely copied."

A Novel Chemical Balance.

THIS is a balance for weighing very small quantities of substances. It acts on the principle of the well-known hydrometer. It is the invention of Mr. H. Joshua Phillips, F. I. C., F. C. S., a consulting chemist, and is illustrated and described in *Engineering* (June 14).

"It consists of a glass cylinder, upon the top of which can be fixed a portable brass ring containing two upright guide rods of brass 6 in. high and ⅛ in. in diameter. The balance proper consists of gilded brass bulbs, into which is screwed an aluminum stem. Screwed on to the top of the stem there are arms, also of aluminum, which are perforated at each end so that the guide-rods can pass through them. Upon the centre of the arms there is a receptacle for a small aluminum scoop or pan to hold the substance to be weighed. Underneath the arms, it will be seen, there are projecting needle-points; there is also a movable point upon one of the guide-rods. The manner of using the instrument is as follows: the cylinder is first filled with cold recently-boiled water; the bulbs and attachments are then dropped in, the guide-rods passing through the perforations of the arms. The balance sinks into the water until the bulbs are just covered. Supposing 0.2 gramme of steel drillings are desired to be weighed. A 0.2 gramme weight is dropped into the portable pan; the bulbs then sink to a definite depth, which can be ascertained by bringing the movable

needle-point upon the guide-rod so as to face the point fixed upon the arm. The weight is now taken off, and the bulbs rise again. The sample of steel drillings is now gradually introduced into the empty pan until the needle points are again opposite each other,—gently tapping the instrument to remove any friction,—and the 0.2 gramme of steel is thus quickly obtained. The range of weight that such an instrument is capable of recording must of necessity be of narrow limits. The depth to which the instrument will sink in the liquid with a given weight, and also its delicacy, will depend upon the diameter of the stem. The diameter of the stem of the balance shown in the sketch is $\frac{1}{16}$ in., and a load of 0.2 gramme will sink it about $3\frac{7}{8}$ in. The height of the cylinder is 10 in., and its diameter $1\frac{7}{8}$ in., and the total length of the stem $5\frac{1}{2}$ in. An instrument of these dimensions will be found useful for weighing steel for carbon tests, &c., and also for weighing certain precipitates, &c."

The Kauri Gum Industry in New Zealand.

THE New Zealand Official Year Book has an article on this subject, reprinted in *The Colliery Guardian*, of which we make the following abstract:

The kauri gum is not chemically a gum, but a true resin. It is the solidified turpentine of the kauri, and occurs in great abundance in fossil condition in the northern part of the Auckland provincial district, from the North Cape to Middle Walkato, and is dug up alike on the driest fernhills and the deepest swamps. The purest samples are found on the Cape Colville peninsula. A large quantity is also obtained from the forks of living trees, but is considered of inferior quality and fetches a lower price. At the present time gum-digging employs nearly, or quite, 7,000 persons, including Maoris and aliens. In the fossil state kauri resin occurs in larger or smaller lumps, from the size of a walnut to that of a man's head. Pieces have been found weighing upwards of 100 lbs. When scraped, the best specimens are of a rich brown color, varying greatly in depth of tint. Sometimes translucent, or even transparent, specimens are found, occasionally with leaves, seeds, or small insects enclosed. When obtained from swamps, the resin is very dark-colored, or even almost black, and fetches a low price. Waikato resin is the darkest of all. Transparent, or semi-transparent, specimens fetch very high prices, being used as a substitute for amber in the manufacture of mouthpieces for cigar-holders, pipes, &c. The great bulk is used in the manufacture of varnishes, and in countries where much varnish is made it holds the chief place in the market. It is exported chiefly to England and the United States.

The digger's equipment is of simple character. A gum-spear (that is, a light, pointed iron rod, fixed in a convenient handle) is used to test the ground; the gum is then dug out with a spade and carried home in a sack. In many cases the spear is dispensed with, and the entire area is dug over to such a depth as the digger thinks likely to be profitable. An old knife is used to scrape the gum, the scrapings being utilized in the manufacture of fire-kindlers.

Gum-digging is a standing resource for the industrious unemployed, and has enabled Auckland to tide over periods of serious commercial depression with comparatively little difficulty. It has also been of vast benefit to hundreds of settlers with but small capital; not a few, who have attained a large measure of prosperity, look back gratefully to the help afforded by casual work on the gum fields. In the commissioners' report it is stated that the average earnings of the digger on leased or private land are 27s. per week, while the actual cost of living is from 10s. to 12s. As the digger has no difficulty in constructing a weather-proof hut, he is not called upon to pay house-rent; his fire-wood also is obtained free of cost, so that he clears from 15s. to 17s. per week above the cost of living. As a matter of fact, the industrious digger is in a more favorable position than the figures just given indicate, since the average earnings are unduly lowered by the presence of a number of old people, who have taken to the work, as well as of others who are content to live from hand to mouth.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*3. Natural Science Training for Engineers. N. S. Shaler (A plea for a broader course in scientific instruction). Eng Mag-Sept. 2800 w.

†15. Sanitary Topography, Climate, and Mineral Springs of New York. A. N. Bell (Treated popularly with table of temperatures and rainfall and other meteorological data). San-July. Serial. 1st part. 1800 w.

†16. Report of Progress in Public Hygiene. S. W. Abbott (Relates largely to sanitation of shops and factories, but includes filtration of sewage and municipal sanitation). San-July. 3200 w.

†20. The History of a Recent Astronomical Discovery. A. W. Drayson (The author claims to have discovered an error in astronomical works with reference to the movement of the poles of the earth relatively to the poles of the ecliptic). New Sci Rev-July. 3700 w.

†21. Climate and High Altitudes. Henry Russell Wray (Relation of altitude to climate with reference to effect of climate upon pulmonary and other diseases). New Sci Rev-July. 1200 w.

†22. The Curvature of Space. John Dolman, Jr. (Discusses hyper space, or non-enclidean space, and the so called fourth dimension). New Sci Rev-July. 4200 w.

49. Dickerson's Process and Apparatus for the Production of Acetylene Gas from Calcium Carbide. Ill. (Copy of drawings, specifications and claims of patent granted to E. N. Dickerson, June 25, 1895). Am Gas Lgt Jour-July 8. 1300 w.

71. The Relation between Composition and Refractory Characters in Fire-Clays. H. Jochum. Am Mfr. & Ir Wld-July 5. 500 w.

†82. Reasons for Predicting the Existence of Argon. C. J. Reed (Mathematical discussion of atomic relationships). Jour Frank Inst-July. 2400 w.

98. Orthochromatic Photography. Ill. Sci Am Sup-July 13. 800 w.

99. The Depths of Space. Robert S. Ball (Reprint from N. Y. Sun). Sci Am Sup-July 13. 2200 w.

100. The New York State Fish Hatchery, Cold Spring Harbor. A. D. (Popular description). Sci Am-July 13. 1800 w.

105. Progress of Sulphuric-Acid-Making. A. D. Ledoux (History; evolution of plant and methods; recent improvements). Mfrs Rec-July 12. 1800 w.

†127. Magnesia in Portland Cement (Conflicting observations; temperature in burning). Ind Engng-June 8. 500 w.

†145. Recent Science. P. Kropotkin (Gives a history of the discovery and a review of the present scientific knowledge of the new elements, argon and and helium; the latter obtained now from Bröggerite as well as Clevéite. A review of the present status of electricity as related to meteorological science, and remarks upon the usefulness and practicability of Arctic exploration). Nineteenth Cent-July. 9000 w.

†146. Color-Music. William Schooling (Suggests a new art that may appeal to the emotions through color, in a manner analogous to the effect of music, since both color and tone are sensorial effects of exterior wave motions). Nineteenth Cent-July. 3800 w.

†147. Some Lessons from Kiel. W. Laird Clowes (Aspects of importance to European nations both from the military and commercial standpoint). Nineteenth Cent-July. 6500 w.

167. Petroleum and Asphalt in Eastern Europe and Asia. Am Mfr & Ir Wld-July 12. 1300 w.

*170. The Rotation of the Earth. Ill. M. F. O'Reilly (Describes a repetition of Faucault's famous experimental demonstration of the earth's rotation performed at Trinity College, Dublin). Engng-July 5. 3000 w.

180. The Problem of Equipoise in Life. Abstract of address by James B. Angell (The individual as a member of society). Elec Engng-July. 1000 w.

183. The Sun. David P. Todd (Present state of knowledge pertaining to the sun. Astronomical; chemical; physical). Science-July 12. 6500 w.

190. Stones as a Source of Fertility. T. H. Hoskins. Gar & For-July 17. 1100 w.

*198. Argon and the Kinetic Theory. C. E. Basevi (A study in molecular physics and a correction of the equation whereby argon has been shown to be monatomic). Nature-July 4. 1200 w.

*199. Argon and Helium in Meteoric Iron. W. Ramsay. Nature-July 4. 1500 w.

*200. Proposed Balloon Voyage to the Pole. W. Nature-July 4. 800 w.

*201. The Relative Powers of Large and Small Telescopes in Showing Planetary Detail. W. F. Denning (Phenomenal results claimed to have been recently obtained with small telescopes). Nature-July 4. 2900 w.

*229. Technical Education Conference (Proceedings of Instruction Committees of various county councils, having for object the extension of the usefulness of the Society of Arts in technical education). Jour Soc of Arts-July 5. 10000 w.

*253. The Kauri Gum Industry in New Zealand (Statistics from Year Book). Col Guard-July 5. 1000 w.

287. Washington Timber (An estimate of available standing timber, suitable for lumber manufacture, in the Pacific Northwest). Sci Am-July 20. 1300 w.

*312. Division of the Bunsen Flame. Lewis T. Wright (On the induction of the explosive wave, and an altered gaseous condition in an ex-

plosive gas mixture by a vibratory movement). Gas Wld–July 13. 4500 w.

316. Petroleum and Asphalt in Eastern Europe and Asia (Localities in the world where found and local characteristics of products). Am Gas Lgt Jour–July 22. 1500 w.

*319. The Electrical Measurement of Starlight. George M. Minchie (System based on the electrical effect of starlight upon photoelectric cells. Measurements of electromotive force of the light of Jupiter, Saturn, Vega, Arcturus, Procyon, etc). Nature–July 11. 2200 w.

*321. Scientific Uses of Liquid Air. Prof. Dewar. Elect'n–July 12. 6000 w.

336. A $2,000,000 Plant. Developing a New Industry in Southwest Virginia. H. S. Fleming (Soda manufacture). Mfrs Rec–July 19. 1200 w.

*341. Report on Metric Weights and Measures (Professional opinions). Chem Tr Jour–July 13. 500 w.

*342. Marble in East Tennessee. Ill. (Topographical uses). Stone–July. 14800 w.

*349. The Dominion of Canada. Ill. W. H. Withrow (Descriptive. Cities; population, etc. Interesting article). Chau–Aug. Serial. 1st part. 2200 w.

*351. Land Wrested from the Sea. Martin Beck (The drainage of the Zuider Zee. The North Sea coast, and Baltic coast). Chau–Aug. 3200 w.

381. Photography in Natural Colors (System as explained by Dr. Joly at soiree of the Royal Society). From the London Times. Sci Am Sup–July 27. 1900 w.

*392. Substitution of Teacher for Text-Book. J. M. Rice (An endeavor to point out where the weakness of teachers lies, and the remedy). Forum–Aug. 3200 w.

*394. The Drift of Population to Cities: Remedies. Henry J. Fletcher. Forum–Aug. 7000 w.

423. The Causes of the Gulf Stream. R. Meade Bache. Sci–July 26. 4400 w.

434. New Oil Fields (Penna., Ohio, W. Va). Am Mfr & Ir Wld–July 26. 800 w.

*460. Notes on Water Gas. George Ritchie (Abstract of paper read at the West of Scotland Iron and Steel Inst). Ir & Coal Tr Rev–July 19. 1800 w.

*480. The Mechanical Testing Station at Charlottenburg (General outline of this national laboratory). Engng, Lond–July 19. 700 w.

*483. Photometric Standards (Report of Board of Trade Committee). Col Guard–July 19. 1500 w.

498. The Iron Pillar near Kolab Minar, Delhi). Ill. A heavy forging of the 4th century). Ir Age–Aug. 1. 500 w.

507. The Manufacture of Artificial Limbs. Ill. (Processes; machines and tools). Sci Am–Aug. 3. 1200 w.

509. The Rawhide Cannon. Ill. (Government tests at Sandy Hook; construction). Sci Am–Aug. 3. 1800 w.

†516. Argon. The New Constituent of the Air. John Tappan Stoddard (The discovery a masterly achievement). Pop Sci M–Aug. 2800 w.

†526. The Earth a Magnetic Shell. Frank H. Bigelow (Mathematical analysis; observatory data). Am Jour of Sci–Aug. 5000 w.

530. The Use of Hot Air in Drying. E. M. Cook (Practical and theoretical). Sci Am Sup–Aug. 3. Serial. 1st part. 2800 w.

531. New Combination of Argon: Synthesis and Analysis. M. Berthelot (Reprint of articles in Chem. News and Nature). Sci Am Sup–Aug. 3. 2500 w.

†544. The Ball Nozzle. Ill. Arthur Kitson (Gives an alleged explanation of the action of the device). Jour Fr Inst–Aug. 2400 w.

†545. Having the Logarithms of Two Numbers, to Find the Logarithm of Their Sum or Difference. Nathaniel Hill (Gives an alleged new method of solving this problem by use of a table of ordinary logarithms). Jour Fr Inst–Aug. 700 w.

*551. Speed in Migratory Flight of Birds. Karl Mills (Condensed from the Proceedings of the Ornithological Society of Vienna. The author is Sec. of the Aeronautical Society of Vienna). Am Eng & R R Jour–Aug. 2600 w.

*552. Pilcher's Soaring Machine. Ill. (Descriptive.) Am Eng & R R Jour–Aug. 700 w.

554. The Limit of Human Endurance of High Air Pressures (Experiment up to 76-8 lbs. pressure). Eng News–Aug. 1. 700 w.

555 The Metric Decimal System of Weights and Measures (Report of J. L. Wilkinson, International Railway Congress, with editorial comment). Eng News–Aug. 1. 3800 w.

586. Cotton Seed Oil and Its Products—A List of the Cotton Seed Oil Mills of the South. Edwin Lehman Johnson (Trade statistics, with editorial comment) Tradesman–Aug. 1. 10500 w.

*600. Insects Injurious to Stored Grain. W. G. Johnson. Am Mill–Aug. Serial. 1st part. 700 w.

†601. Glacial Notes from the Planet Mars. E. W. Claypole (Modern view of supposed glaciation). Am Geol–Aug. 3000 w.

†602. Correlations of Stages of the Ice Age in North America and Europe. Warren Upham. Ill. (Geological.) Am Geol–Aug. 5000 w.

†654. How Translatory Movement May Be Derived from Vibratory Movement. J. Woodbridge Davis (A study in molecular physics). Sch of Mines Quar–July. 3800 w.

†657. The Condensation of Fumes by Static Electricity. Malvern W. Iles (Places on record interesting facts and part of the literature relative to the use of static electricity for condensation of fog, mist, dust and smoke). Sch of Mines Quar–July. 800 w.

†683. The Analysis of Vulcanized India-Rubber. By a member of the British Society of Chemical Industry. Ind Rub Wld–Aug. 10. 3600 w.

We supply copies of these articles. See introductory.

BOOKS OF THE MONTH

AN ELEMENTARY TEXT-BOOK OF HYDROSTATICS. By William Briggs, M. A., F. C. S., F. R. A. S., general editor of the Tutorial Series; principal of University Correspondence College; and G. H. Bryant, M. A., Smith's Prizeman, fellow of St. Peter's College, Cambridge, authors of "Co-ordinate Geometry" and "An Elementary Text-book of Mechanics." London and New York: W. B. Clive. [208 pp., 5″×7″, cloth. Price, 50 cts.]

THIS book includes such portions of hydrostatics and pneumatics as one must know in order to pass examinations for the London matriculation. The principle is adopted of relying upon first principles, rather than memorizing mathematical formulas. The method is a good one, and the whole subject is presented in a clear, comprehensive, and effective manner. As with all of the books of this series, very numerous and well chosen practical examples are given for exercises. The principles are, therefore, thoroughly impressed upon the mind by practical work.

MOTIVE POWERS AND THEIR PRACTICAL SELECTION. By Reginald Bolton, past president of the Civil Mechanical Engineers' Society, associate member of the Institution of Civil Engineers, and member of the London Chamber of Commerce. New York: Longmans, Green & Co., and London, 1895. [257 pp., 5″×7½″, cloth. Price, $2.25.]

TREATS comprehensively of available motive powers for driving machinery. One of its principal merits is the very thorough manner in which it deals with the subject of oil engines, now fast coming to the front among the motors of the world. Particularly in Europe has there been recently a very great extension of the use of oil engines. In America the employment of gas engines has been more prevalent, but this will be followed soon and rapidly by the employment of oil engines, when the economy, simplicity, and convenience of these have become better known. The author is a gentleman of high attainments, well qualified to treat the subject he has undertaken to discuss. The book is printed in admirable style, with clear, bright type and well-executed diagrams illustrating the text where needed. Those desiring information upon the entire range of motors now in use will find this book a valuable help.

THE TUTORIAL PHYSICS. VOLUME IV. A TEXT-BOOK of Magnetism and Electricity, with 160 illustrations and numerous examples. By R. Wallace Stewart, D. Sc., second edition, 1894, London and New York: W. B. Clive. [344 pp., 5″×7″. Price, $1.00.]

THE preface to the first edition of this book states that it was primarily written for the use of candidates for the matriculation, intermediate science, and preliminary scientific examinations of the University of London. This probably characterizes the nature of the work sufficiently to obviate the necessity of further remarks upon its original purpose and scope. The book has, however, been carefully revised, and much new matter has been added in the second edition, so that it is now brought up to date of publication. It is a thoroughly good text-book upon the subject treated. It contains some of the best problems for exercises and application of formula in electricity that we have met with.

THE MECHANICAL ENGINEERS' POCKET-BOOK. A reference book of rules, tables, data, and formulas for the use of engineers, mechanics, and students. By William Kent, A. M., M. E., consulting engineer, M. A. S. M. E., A. I. M. E. First edition. New York: John Wiley & Sons, 1895. [1087 pp., 4″×6½″. Folding morocco cover, pocket-book style, gilt edges. Price, $5.00.]

A new-comer in this well-occupied field. The author states that it is largely made up from notes acquired in his own practice as an engineer. These have also been added to by collections of engineering facts and figures, the work of many years. At the request of the publishers, a selection from this large mass of material has been made, and the result is present in this book. The general style of printing, paper, and binding are very much like that of Haswell's book, with which almost every American engineer is familiar; there appears, however, to be in this book greater symmetry of arrangement, and facts pertaining to any particular depart-

ment of engineering are grouped together in a manner superior to that of some others we have seen. A very thorough index is also supplied. Of course, in the first edition of a book of this kind, errors of commission and omission are likely to have occurred, and the publishers request that those who become readers of the volume will kindly call their attention to any errors they may discover. It has been impossible to examine this large collection of data and formulæ closely in every part, but we will say that, in a general inspection of it, it has appeared to us to be a very well-prepared and reliable book.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland L. Kneass, C. E., M. A. S. M. E., Franklin Institute, and Engineers' Club of Philadelphia. New York: John Wiley & Sons, 1894. [132 pp., 6″×9″, cloth. Price $1.50.]

THIS book contains an account of the early history of the Giffard Injector, and the development of the invention to its modern form; also notes upon the shape and proportion of the tubes, and the wear of the different parts, with a review of the theory, and illustrated descriptions of the most important locomotive and stationary injectors, accompanied by numerous tables and diagrams of tests. It has been the object of the author to give greater prominence to the practical side of the discussion than to the theoretical, in order to make the book useful both to those who operate injectors and those who are responsible for the motive power of large railroads. The purely mathematical theories, however, which are of such interest to students, have not been neglected. The theoretical side of the question has been considered by what the author considers the simplest method; he approaches the subject from a mechanical point of view, considering the injector as an apparatus in which the momentum of a jet of steam is transferred to a more slowly moving body of water, producing a resultant velocity sufficient to overcome the pressure of the boiler. A very cursory glance at the book is convincing that the author has undertaken to treat a subject with which he is thoroughly familiar. The style and method of treatment are good, and the printing, paper, and binding are of that high order characteristic of the books issued by its publishers.

ELECTRICAL ENGINEERS' AND STUDENTS' CHART AND Hand-Book of the Brush Arc Light System. By H. C. Reagan, Jr. New York: Norman W. Henley & Co. [48 pp., 6″×9″, cloth. Price, $1.00.]

THE purpose of this book is to supply theoretical and practical instruction with reference to the simply constructed, yet little understood, Brush dynamo; it is, therefore, adapted to the wants of students, engineers, and dynamo-tenders. The explanations and instructions are completely up to date, giving descriptions of the very latest Brush dynamo. A novel and very useful feature, which might well be imitated in other engineering works, is a detached revoluble celluloid chart. By turning this in different positions the manner of cutting the lines of force, the directions of the flow of current induced in the armature coils, the method of computing current, the flow of current to the external circuit and return to the negative brush, are all very clearly shown, as is also the position for setting the brushes. This chart is contained in a pocket made inside of the cover. Such charts might be prepared illustrating valve motions and other working parts of machines in other departments of engineering. Blank pages are left at the end of the text for memoranda. We can recommend this book without hesitation to all who desire to become familiar with the Brush system.

STREET RAILWAY INVESTMENTS. A SUPPLEMENT TO the Street Railway Journal. H. B. Hollins & Co., Bankers, corner Wall and Broad Streets, New York. [248+LXIII pp., 9½″×13″.]

THIS work is claimed to be a far more complete and satisfactory presentation of the street-railway interests of the United States than has ever before appeared. It contains the municipal statistics of the large cities and the maps of the principal systems very clearly and conveniently arranged and carefully indexed. The publisher states that accuracy has been secured by sending proof to every street-railway company for revision, in advance of publication.

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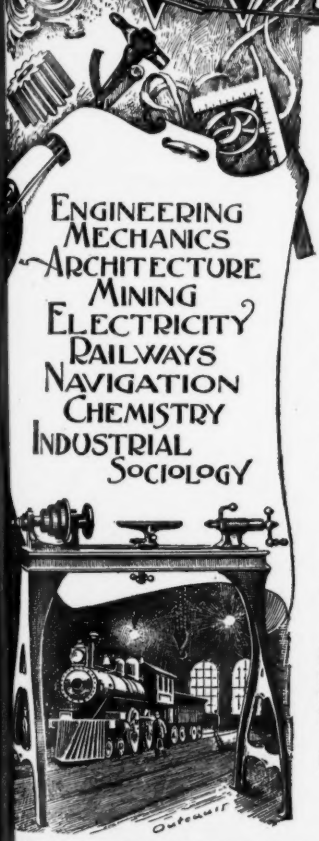
EDITED BY JOHN R. DUNLAP



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The Business Situation in Review—
Factors in the Recent Improvement. NEWTON SHARP. 1005

The Emancipation of Labor by Machinery—
An Economic Delusion Exploded. A. E. OUTERBRIDGE, Jr. 1012

Natural Science Training for Engineers—
Improved Character of Scientific Education. N. S. SHALER. 1021

Labor Legislation in the United States—
The Multiplicity of Needless Laws. GEO. KIRBY HOLMES. 1027

The Modern Problem of Grade Crossings—
Experience and Practice in New England WM. O. WEBBER. 1034

The Earliest Transatlantic Steamships—
Covering the Period from 1819 to 1855. S. W. STANTON. 1051

Surveying and Mapping a City—
The Great Importance of Accurate Work. C. H. RICE. 1066

The Revolution in Steel Making—
Importance of the Open Hearth Process. WM. METCALF. 1072

Ontario Drain Tunnel and Electric Plant—
A Work of Interest to Electrical and Mining Men. C. R. McKAY. 1079

The Architecture of Modern Hospitals—
Their Interior Design and Location. E. C. GARDNER. 1086

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Books of the Month, 1193 **Improved Machinery,** 1195

FOR INTRODUCTION TO AUTHORS, SEE PAGE 5.

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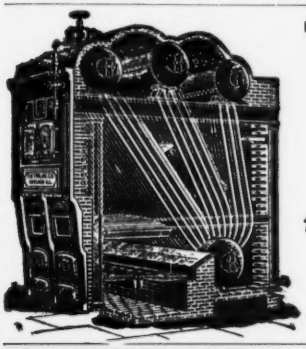

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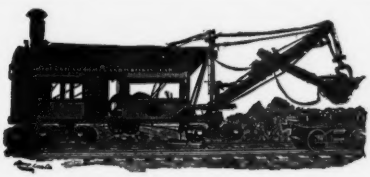

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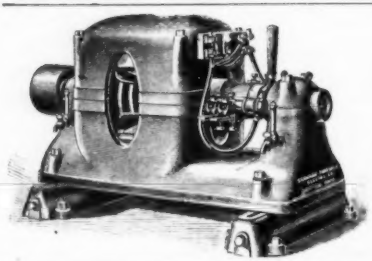

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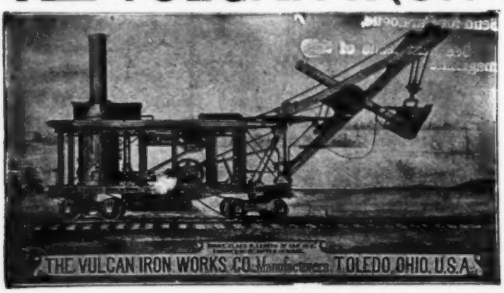

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AUTHORS AND PAPERS THIS MONTH.

NEWTON SHARP (*The Business Situation in Review*)=Born at Newport, Va., 1865; received business education; employed in banking for several years; financial reporter for *Evening Sun* (New York) 1891 to 1893; since latter date financial editor of the same paper; also editorial writer on various subjects; has acted as financial correspondent of Chicago and Boston newspapers.

ALEXANDER EWING OUTERBRIDGE, JR. (*The Emancipation of Labor by Machinery*)=Born in Philadelphia, 1850; educated in Episcopal Academy and by private tutor in analytical chemistry; lectured on physics and taught English branches at Episcopal Academy 1868-69; appointed assistant in assay laboratory of United States Mint, Philadelphia, 1869; appointed Commissioner to Centennial Exposition, representing Colonies of British Guiana 1876; invented and tested at United States Mint, Philadelphia, an apparatus for saving volatilized bullion, which was fully endorsed and recommended for adoption in official letters of the late Prof. James C. Booth, then "melter and refiner," and the late William E. DuBois, then "chief assayer," 1879; transferred to Mint at New Orleans to organize Assay Department 1879; resigned from Mint 12 years later to accept position as metallurgist and experimentalist at car-wheel works of A. Whitney & Sons, Philadelphia 1881; appointed member of board of examiners of International Electrical Exposition, Philadelphia 1885; awarded the John Scott Legacy medal and premium by the city of Philadelphia on recommendation of the Franklin Institute for discovery of process of casting molten metals on carbonized fabrics and obtaining replicas thereof, 1887; resigned from car-wheel works and accepted a similar position at machine tool works of Wm. Sellers and Co., Incorporated, 1888. He has been a voluminous contributor to scientific and technical publications of first rank and has delivered addresses before numerous learned bodies.

NATHANIEL SOUTHGATE SHALER (*Natural Science Training for Engineers*)=Born in Campbell county, Ky., February 20, 1841. He was graduated from the Lawrence Scientific School in 1862; has been a teacher of geology in Harvard University since 1864; was State Geologist of Kentucky from 1873 to 1880, and Geologist of the United States Geological Survey from 1883 to 1892; has published about a dozen volumes and about three hundred papers and memoirs, mostly relating to geological subjects; is now dean of the Lawrence Scientific School.

GEORGE KIRBY HOLMES (*Labor Legislation in the United States*)=Born in Great Barrington, Mass., in 1856; received a high school education, followed by extensive reading and attention to social questions. Was admitted to the Massachusetts bar in 1877, but circumstances soon afterward let him into newspaper work and constant writing for various periodical publications. His study of the distribution of wealth from a statistical point of view induced the Massachusetts Bureau of Statistics of Labor to investigate the subject, and the first installment of results is to be published within a year. In 1889 he was appointed Special Agent in charge of the Division of Farms, Homes and Mortgages of the Eleventh Census, which conducted two novel investigations, one relating to real estate mortgages and the other to farm and home proprietorship and indebtedness, the reports of which will be issued this year. No nation had previously investigated the latter subject, nor the Census Office the former, and they both constituted a larger statistical work than had ever been undertaken in this country previous to the national census of 1870. He is now chief of the Crop Reporting section, Division of Statistics, Department of Agriculture, Washington, D. C. His numerous magazine articles relate mostly to wealth, debt, legislation, and the mathematical treatment of statistics.

WILLIAM O. WEBBER (*The Modern Problem of Grade Crossings*)=Born Jan. 4, 1856, Springfield, Mass. Educated in the public schools of Manchester and Portsmouth, N. H., and

Grammar School No. 35 in New York city; also private student with Samuel Webber, M. E., and his father, Col. Samuel Webber, C. E. Apprentice machinist 1871–73, Manchester Locomotive Works, Manchester, N. H., apprentice engineer, 1873–74, Boston & Maine R. R.; journeyman machinist, 1874, Cotton Machinery, Whitehead & Atherton Machine Co., Lowell, Mass.; mechanical engineer, 1875, Toledo, Peoria & Warsaw Ry., Peoria, Ill.; engineering representative, 1876, Centennial Exhibition, Chapman Valve Co., Boston and Indian Orchard, Mass., and assistant in tests of turbine water wheels; engineer of tests, 1876–81, Chicago, Burlington & Quincy R. R., Aurora, Ill., superintendent, 1881–82, Allen Paper Car Wheel Works, Pullman, Ill., superintendent and partner, 1882–87, Lawrence Machine Co., Lawrence, Mass, manufacturing printing presses, pumps, dynamometers, power hammers, etc.; consulting engineer, 1887–89, Boston, Mass., member State Board of Engineers on abolitition of grade crossings; general superintendent, 1889–94, Erie City Iron Works, Erie, Pa., high speed automatic and plain stationary engines and boilers, where he built new shops, electric lighting plant, designed new styles of engines throughout and systematized the process of manufacture; resident engineer H. R. Worthington Co, Boston, Mass., on water works, 1894–95; since Jan. 1, 1895, consulting engineer, Nos. 78–79 Mason Bldg., Boston, Mass. Has contributed papers to the A. S. M. E. embodying original research on the performance and efficiencies of centrifugal pumping machinery and other subjects; also to the *The South* on narrow gauge railroads and their equipments; to *Machinery* on steam engineering talks to young engineers; to *Cassier's*, on boiler making and on testing materials, and has delivered lectures at the Mass. Institute of Technology on friction and lubrication. Member of American Society of Mechanical Engineers, Boston Society of Civil Engineers, and associate member of United States Naval Institute.

SAMUEL WARD STANTON (*The Earliest Transatlantic Steamships*)=Born January 8, 1870, at Newburgh, N. Y.; youngest son of the late Samuel Stanton, of the shipbuilding firm of Ward, Stanton & Co.; became part owner of the marine paper *Seaboard*, of New York, 1891; awarded medal and diploma at World's Columbian Exposition, Chicago, 1893, for pen drawings of American steam vessels.

C. H. RICE (*Surveying and Mapping a City*)=Born in Wayne Co., Missouri; took a special course in mathematics and chemistry at De Pauw University, Greencastle, Ind.; has been Asst. Engineer M. of W. on Penna. Lines west of Pittsburgh and Division Engineer on N. & W. R. R., Chief Draughtsman Official Survey of Roanoke and Asst. City Engineer Roanoke, Va.; is at present computor on Topographical Survey of the city of Baltimore.

WILLIAM METCALF (*The Revolution in Steel Making*)=A well-known Pittsburgh manufacturer and metallurgist; at present travelling abroad. As a young man he entered the employ of the Knapp Fort Pitt Foundry during the Civil War, when they made the famous Rodman guns; from there he came to the firm of Miller, Metcalf and Parkin, afterwards incorporated as the Crescent Steel Co., of which corporation he is a managing director. Past president of both the American Institute of Civil Engineers, and of the American Institute of Mining Engineers. Without doubt one of the greatest authorities on practical iron and steel making.

C. R. McKAY (*Ontario Drain Tunnel and Electric Plant*;=Studied electrical engineering in Johns Hopkins University, 1892–93; one of the judges at the late World's Fair, Chicago, department of electricity; engaged on special work-testing; at present a prosperous consulting and contracting engineer at Salt Lake City; has had charge of important work in installing transmission plants. C. R. McKay was born in 1869 at North Adams, Mass. His early education was obtained in private schools and Military academies. He followed the undergraduate course in physics and mathematics at Johns Hopkins University, Baltimore, subsequently completing the post graduate course in electrical engineering at the same institution. In 1890 he made a tour of inspection of European Electrical Installations and in 1893 was appointed member of the Board of Electrical Awards at the Columbian Exposition held in Chicago. Since that time he has been engaged in electrical consulting work at Salt Lake City, Utah. He is an Associate member of the American Institute of Electrical Engineers. Has lived for many years in mining regions of the west, and has devoted especial attention to commercial testing work, etc.

E. C. GARDNER (*The Architecture of Modern Hospitals*)=Born in Ashfield, Mass., in 1836; 1856 to 1862 engaged in teaching; studied architecture in Springfield, Mass., in 1862; soon after went into business alone; first book on domestic architecture was published in 1872, followed by two other similar volumes; author of "Common-sense in Church Building," "The House that Jill Built," and "Village and Suburban School Houses;" member of Boston Society of Architects; 1885 till 1888 editor of *Builder;* at present senior member of the architectural firm of Gardner, Pyne & Gardner, Springfield, Mass.

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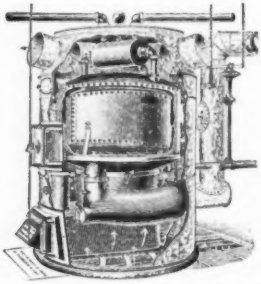

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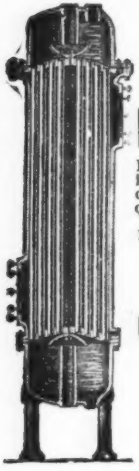

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Alphabetical Index. Page 17.

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Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Walker Manufacturing Co., Cleveland, Ohio.

Anti Friction Metals.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Architectural Iron.
Addyston Pipe and Steel Co., Cincinnati, Ohio.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
The Continental Iron Works, Brooklyn, N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Architectural Sheet Metal Work.
Canton Steel Roofing Co., Canton, Ohio.
Merchant & Co., Philadelphia, Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Asphalt Car Roofing.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.

Asphalt Cement and Felt.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.

Asphalt Damp Course and Deadening
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.

Asphalt Paint.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.

Automatic Water Tanks.
Automatic Water Tank Co., 143 Liberty St., N. Y.

Ball Nozzles
American Ball Nozzle Co., 837 Broadway, N. Y.

Ballast Unloaders.
Marion Steam Shovel Co., Marion, Ohio.

Baths.
Standard Manufacturing Co., Pittsburg, Pa.

Belt Dressing.
Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.
Home Rubber Co., Trenton, N. J.
Main Belting Co., Philadelphia, Pa.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Belt Lacing.
Bristol Co., Waterbury, Conn.

Blacksmiths' Tools.
Buffalo Forge Co., Buffalo, N. Y.
Merrill Bros., Brooklyn, N. Y.

Blast Furnaces.
Maryland Steel Co., Sparrows Point, Md.

Blowers.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Fraser & Chalmers, Chicago, Ill.

Boilers.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Atlantic Works, East Boston, Mass
Buckeye Engine Co., Salem, Ohio.
H. E. Collins & Co., Pittsburg, Pa.
Continental Iron Works, Brooklyn, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Heine Safety Boiler Co., St. Louis, Mo.
Maryland Steel Co., Sparrows Point, Md.
Mundy, J. S. Newark, N. J.
Riter & Conley, Pittsburg, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co, Chester, Pa.

Boiler Compound.
Geo. W. Lord, Philadelphia, Pa.

Boiler Fronts and Fittings.
Reliance Gauge Co., Cleveland, Ohio.
Riter & Conley, Pittsburg, Pa.
Vulcan Iron Works, Toledo, Ohio.

Boring Machines.
Fitchburg Machine Works, Fitchburg, Mass.
Waterman Machine Tool Co, Oakland, Me.

Bolts, Nuts, and Washers.
Milton Mfg. Co., Milton, Pa

Bricks.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.

Bridge Builders.
F. C. Austin Mfg. Co., Chicago, Ill.
Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co, Canton, Ohio.

Brick and Tile Machinery.
F. D. Cummer & Son Co, Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.

Building Materials.
Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co., Cleveland, Ohio.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
E. B. Moore & Co., Chicago, Ill.
Harrison Bros & Co., Philadelphia, Pa.
Henry Maurer & Son, 420 E 23d St., N. Y.
James L. Foote, Slatington, Pa.
Joseph Dixon Crucible Co., Jersey City, N. J.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Merchant & Co., Philadelphia, Pa.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Samuel H. French, & Co., Philadelphia, Pa.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co, 2 Liberty St., N. Y.
Warren Chemical and Mfg. Co, 27 Fulton St, N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Cable Railways.
Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Cameras.

Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Carpenters' Tools.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.

Chemical Works Machinery.

Fraser & Chalmers, Chicago, Ill.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.

Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.

J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

A. J. Beckley & Co., Meriden, Conn.
Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Geo. T. McLauthlin & Co., Boston, Mass.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies.

F. C. Austin Mfg. Co., Chicago, Ill.
Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W. J. Clark & Co., Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corliss Engines

Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
F. C. Austin Mfg. Co., Chicago, Ill.
Bradley Pulverizer Co., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Geo. T. McLauthlin & Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Damper Regulators.

Standard Thermometer Co., Peabody, Mass.

Diamond Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago Ill.

Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & J. Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Waterman Machine Tool Co., Oakland, Me.

Drop Presses.

Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Dynamos.

Commercial Electric Co., Indianapolis, Ind.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lawrence Poland, Cincinnati, Ohio
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

Commercial Electric Co., Indianapolis, Ind.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lawrence Poland, Cincinnati, Ohio.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Bristol Co., Waterbury, Conn.
Commercial Electric Co., Indianapolis, Ind.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Lawrence Poland, Cincinnati, Ohio.
Queen & Co., Inc., Philadelphia, Pa.
Shawhan-Thresher Electric Co., Dayton, O.
Standard Electric Co., Chicago, Ill.
Standard Thermometer Co., Peabody, Mass.
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Spinney, Virtue & Co., Lynn, Mass.

Electroplating and Electrotyping Machines.

Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators, Steam, Hydraulic, Electric.

M. J. O'Donnell & Co., Cleveland, Ohio.

Emery Wheels.

Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
John W. Harmon, Boston, Mass.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum

Otto Gas Engine Works, Philadelphia, Pa.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Robert Wetherill & Co., Chester, Penn.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Fire Arms.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Fire Department Equipment.
American Ball Nozzle Co., 837 Broadway, N. Y.

Fireproof Building Material.
Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Empire Fire Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Merchant & Co., Philadelphia, Pa.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Pioneer Fireproof Construction Co., Chicago Ill.
Riter & Conley, Pittsburg, Pa.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co. Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Flexible Shafts.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, M
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.
Toledo Machine & Tool Co., Toledo, Ohio.

Forges.
Buffalo Forge Co., Buffalo, N. Y.

Forgings.
Sternbergh & Son, Reading, Penna.
Milton Mfg. Co., Milton, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.

Freight Car Couplers.
McConway & Torley Co., Pittsburg, Pa.

Furnace Builders.
Fraser & Chalmers, Chicago, Ill,
Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture.
The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage and Valve Co., Boston, Mass.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.
Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.
U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Continental Iron Works, Brooklyn, N. Y.
The Fairbanks Co, New York.

Gear Cutters.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.
Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grading Machines.
F. C. Austin Mfg. Co., Chicago, Ill.

Grain Elevator Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.
Samuel H. French & Co., Philadelphia, Pa.

Grates.
Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Grips, Cable Railways.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.
Sheffield Car Co., Three Rivers, Mich.

Hangers.
SEE PULLEYS, ETC.

Hardwood Floors.
E. B. Moore & Co., Chicago, Ill.

Hardware Manufacturers.
Charles H. Besly & Co., Chicago, Ill.
Merrill Bros, Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Heating and Ventilating Apparatus.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Huyett & Smith Mfg. Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.
American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co, Chicago, Ill.
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.

Hod Hoisting Machinery.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.
Empire Fire-Proofing Co., Pittsburgh, Pa.

Hose, Steam and Fire.
Crosby Steam Gage and Valve Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
New York Belting & Packing Co., Ltd., New York.
Maryland Steel Co., Sparrows Point, Md
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

O. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Limited, 13 Park Row, N. Y.

Insulating Paper.

Standard Paint Co., 2 Liberty St., N. Y.

Iron Working Machinery.

Charles H. Besly & Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wilkinson Co., Chicago, Ill.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Oakland, Me.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Lamps, Electric.

General Electric Co., 44 Broad St., N. Y.
Standard Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.

Lead Corroders.

Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa,

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 115 Broadway, N

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.

Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Armstrong Bros. Tool Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Q. & C. Co., Chicago, Ill.
G. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Oakland, Me.
The Wilkinson Co., Chicago, Ill.

Mantels.

Samuel H. French & Co., Philadelphia, Pa.

Marine Machinery.

W. A. Crook & Bros. Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
John W. Harmon, Boston, Mass.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Merchant Steel.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metal Punching and Shearing.

Harrington & King Perforating Co., Chicago, Ill.

Meters, Electric.

General Electric Co., 44 Broad St., N. Y.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.

Cincinnati Milling Machine Co., Cincinnati, Ohio
Ingersoll Milling Machine Co., Rockford, Ill.

Mining Machinery.

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Geo. T. McLauthlin & Co., Boston, Mass.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Mining Screens.

Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Mortar Colors.

Samuel H. French & Co., Philadelphia, Pa.

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Fort Wayne Electric Corporation, Fort Wayne, Ind
General Electric Co., 44 Broad St., N. Y.

Interior Conduit & Insulation Co., New York.
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Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Nickel.

Canadian Copper Co., Cleveland, O.

Nut Locks.

Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups.

Sherwood Mfg. Co., Buffalo, N. Y.

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Winslow Bros. Co., Chicago, Ill.

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Sherwood Mfg. Co., Buffalo, N. Y.
Quaker City Rubber Works, Philadelphia, Pa.

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Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Harrison Bros. & Co., Philadelphia, Pa.
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Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio
Robt. Wetherill & Co., Chester, Pa.

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Atlantic Works, East Boston, Mass.

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Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.

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Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

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Armstrong Mfg. Co., Bridgeport, Conn.

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Charles Millar & Son, Utica, New York.
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Morris, Tasker & Co., Philadelphia Pa.

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C. B. Rogers & Co., Norwich, Conn.

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Samuel H. French & Co., Philadelphia, Pa.

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Hanson & Van Winkle Co., Newark, N. J.

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Long & Allstatter Co., Hamilton, Ohio.
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General Electric Co., 44 Broad St., N. Y.

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Walker Manufacturing Co., Cleveland, Ohio.

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Coldwell-Wilcox Co., Newburgh, N. Y.
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Van Auken Steam Specialty Co., Chicago, Ill.

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Sullivan Machinery Co., Chicago, Ill.

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Edw. P. Allis Co., Milwaukee, Wis.
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Fishkill Landing Machine. Co., Fishkill, N. Y.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

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Bradley Pulverizer Co., Boston, Mass.
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Pumps and Pumping Machinery.

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A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Connersville Blower Co., Connersville, Ind.
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Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
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A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
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Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
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H. B. Smith Co., 137 Center St., N. Y.

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Westinghouse Air Brake Co., Pittsburgh, Pa.
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Railway Feed Wires.

The Okonite Co., Limited, 13 Park Row, N. Y.

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General Electric Co., 44 Broad St., N. Y.

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Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
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Niles Tool Works, Hamilton, Ohio.
Q. & C. Co., Chicago, Ill.

C. B. Rogers & Co., Norwich, Conn.
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Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Waterman Machine Tool Co., Oakland, Me.

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A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Harrington & King Perforating Co., Chicago, Ill.
Iron City Tool Works, Ltd., Pittsburg, Pa.
Milton Mfg. Co., Milton, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Sheffield Car Co., Three Rivers, Mich.
Sternbergh & Son, Reading, Penna.

Railways, Portable.

C. W. Hunt Co., 45 Broadway, N. Y.

Railway Supplies.

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Sheffield Car Co., Three Rivers, Mich.

Railway Track Tools.

Iron City Tool Works, Ltd., Pittsburg, Pa.

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Hepe, Koven & Co., 18 Spruce St., N. Y.

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Harrison Bros. & Co., Philadelphia, Pa.

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F. C. Austin Mfg. Co., Chicago, Ill.
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Vulcan Iron Works, Toledo, Ohio.

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F. C. Austin Mfg. Co., Chicago, Ill.
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Edw. P. Allis Co., Milwaukee, Wis.
F. C. Austin Mfg. Co., Chicago, Ill.
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Rock Drills.

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Harrington & King Perforating Co., Chicago, Ill.

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Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
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Sherwood Mfg. Co., Buffalo, N. Y.
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Steamships and Tow Boats.

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Van Auken Steam Specialty Co., Chicago, Ill.

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Steel Importers.

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Steel Manufacturers.

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Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

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F. C. Austin Mfg. Co., Chicago, Ill.

Street Sweepers.
F. C. Austin Mfg. Co., Chicago, Ill.

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Merchant & Co., Philadelphia, Pa.
Samuel H. French & Co., Philadelphia, Pa.

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Gummey, McFarland & Co., Philadelphia, Pa.
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Merchant & Co , Philadelphia, Pa
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C. W. Hunt Co., 45 Broadway, N. Y.

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Robert Poole & Son Co., Baltimore, Md.
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Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass.

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Ross Valve Co., Troy, N. Y.
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Loomis & Nyman, Tiffin, Ohio.

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Harrison Bros. & Co , Philadelphia, Pa.

Window Guards (Jail Work.)
Harrington & King Perforating Co., Chicago, Ill.

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Charles H. Besly & Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

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Fraser & Chalmers, Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

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Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wire Rope Transmission.
Jeffrey Mfg. Co., Columbus, Ohio.

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E. B. Moore & Co., Chicago, Ill.

Wood Stains.
Harrison Bros. & Co., Philadelphia, Pa.

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C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.

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Marion Steam Shovel Co., Marion, Ohio.

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Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.

Zinc White.
Harrison Bros. & Co., Philadelphia, Pa.

ALPHABETICAL INDEX TO ADVERTISERS.

Adams, Alton D. 21
Addyston Pipe and Steel Co. 44
Allis Co., Edw. P. 63
Alteneder & Sons, Theo. 23
American Ball Nozzle Co. 32
American Boiler Co. 75
American Injector Co. 58
American Well Works 42
Armstrong Bros. Tool Co. 69
Armstrong Mfg. Co. 77
Ashworth, D 21
Atlantic Works 62
Austin Mfg. Co., F. C. 32
Automatic Water Tank Co. 34

Bacon, Earl C. 50
Baldwin Locomotive Works 54
Ball & Wood Co. 61
Barnes Co., W. F. & John 65
Berlin Iron Bridge Co. 71
Besly & Co., Charles H. 59
Bliss School of Electricity 23
Bradford Mill Co. 68
Bradley Pulverizer Co. 45
Brandis Sons Co. 23
Bristol Company 55
Brixey, W. R. 56
Brooks & Co, T. H. 73
Brown Hoisting and Conveying Machine Co. 3
Bryan, Wm. H. 22
Buckeye Engine Co. 64
Buffalo Forge Co. 34
Bullock Mfg. Co., M. C. 63
Byers Machine Co., John F. 49

Cameron Steam Pump Works, A. S. 41
Canadian Copper Co 7
Canton Steel Roofing Co 70
Carlin's Sons, Thomas 48
Carlisle Mfg. Co. 55
Chapman Valve Mfg. Co. 44
Cheltenham Military Academy 23
C., M. & St. P. Ry. 26
Chrome Steel Works 70
Cincinnati Milling Machine Co. 4
Clark & Co., W. J. 49
Clayton Air Compressor Works 3
Cleveland Twist Drill Co. 66
Clonbrock Steam Boiler Co. 61
Coldwell-Wilcox Co. 44
Collins & Co., H. E. 58
Commercial Electric Co. 56
Comstock, Wm. T. 23
Connersville Blower Co. 28
Conard, Thos. P. 24
Conradson, C. M. 21
Continental Filter Co. 44
Continental Iron Works 39
Contractors' Plant Mfg. Co. 48
Cooper, Hewitt & Co. 50
Corthell, Elmer L. 21
Crook & Bro.'s Co., W. A. 39
Crosby Steam Gage and Valve Co. 62
Cummer & Son Co., F. D. 54

Davis, Lewis K 21
Dayton Globe Iron Works 55
Deane Steam Pump Co. 40
Detroit Graphite Mfg. Co. 70
Dixon Crucible Co., Joseph 7
Dunn Mfg. Co. 43

Eastern Electric Cable Co. 56
Electro Light Engraving Co 19
Empire Fire-Proofing Co. 72
Engineering Employment Bureau. 21
Eureka Nut Lock Co. 53
Everette, Dr. Willis E. 22

Fairbanks Company 59
Fargusson, M. 21
Filley Mfg. Co., A. E. 53
Fishkill Landing Machine Co. 76
Fitchburg Machine Works 68
Foote, James L. 73
Fort Wayne Electric Co. 28
Fraser & Chalmers 47
French & Co., Samuel H. 70
Frick Company 62
Fuller, Wm. B. 22

Garvin Machine Co 24
Gates Iron Works 48
General Electric Co. 56
Globe Co. 27
Gooding, C. T. 22
Gorton & Lidgerwood Co. 76
Goubert Mfg. Co. 8
Gummey, McFarland & Co. 73

Hanson & Van Winkle Co. 57
Harrington & King Perforating Co. 8
Harrisburg Foundry and Machine Works 33
Harrison Bros. & Co. 4
Harvard University 23
Hazelton Boiler Co. 76
Heine Safety Boiler Co. 60
Hepe, Koven & Co. 74
Hohmann & Maurer Mfg. Co. 59
Home Rubber Co. 29
Hooven, Owens & Rentschler Co. 62
Hunt Co., C. W. 51
Hussey, Ernest Bertrand 21
Huyett & Smith Mfg. Co. 74

I. C. R. R 26
Ide, A. L. & Son 23
India Rubber Publishing Co. 46
Ingersoll Milling Machine Co. 68
Ingersoll-Sergeant Drill Co. 45
Interior Conduit & Insulation Co. 57

Jeffrey Mfg. Co. 49
Jennings, E. P. 21
Jessop & Sons, Limited, William 54
Jones & Lamson Machine Co. 66

Kelly Co., O. S. 33
Kennedy, Julian 22
Keuffel & Esser Co. 7

Laborers' Instruction Pub. Co. 23
Laidlaw-Dunn-Gordon Co. 41
Lawrence Scientific School 25
Lehigh Valley Railroad 26

ALPHABETICAL INDEX

Lidgerwood Mfg. Co. 78
Link-Belt Engineering Co. 49
Long & Allstatter Co 67
Loomis & Nyman 42
Lord, Geo. W. 58

McGowan Co., John H. 42
McLauthlin & Co., Geo. T 48
McNeal Pipe and Foundry Co. 42
McRae, A. L. 21
Main Belting Co. 29
Manhattan Rubber Mfg. Co. 29
Manning, Maxwell & Moore 65
Manufacturers Advertising Bureau 2
Marine Iron Works 3
Marion Steam Shovel Co. 3
Maryland Steel Co. 60
Maurer & Son, Henry 72
Merrill Bros. 68
Michigan Mining School 23
Michigan Pipe Co 54
Millar & Son, Chas 43
Milton Mfg. Co 53
Monon Route 26
Moore Mfg. and Foundry Co. 54
Moore & Co., E. B. 70
Morris, Tasker & Co. 55
Morse, W. F. & Co. 39
Morse Twist Drill & Machine Co. 66
Mundy, J. S. 49

National Pipe Bending Co. 60
N. J. Car Spring and Rubber Co. 34
New York Air Brake Co. 52
New York Central Iron Works Co. 73
New York Machinery Depot 24
New York Belting & Packing Co. 39
Nicholson File Co. 77
Nicholson, Frank 21
Niles Tool Works 65
Norwalk Iron Works Co. 47

Odorless Excavating Co. 33
O'Donnell & Co., M. J. 73
Ohio Pipe Co. 43
Okonite Co., Limited 77
Otto Gas Engine Works 57

Pease Furnace Co., J. F. 8
Penberthy Injector Co. 58
Phosphor Bronze Smelting Co., Limited 55
Pittsburgh Testing Laboratory, Limited 22
Poland, Lawrence 57
Pond Machine Tool Co 65
Poole & Son Co., H. 69
Porter & Co., H. K. 54
Potter, Alexander 21
Prentiss Tool and Supply Co. 77
Pulsometer Steam Pump Co. 42

Q. & C. Co. 67
Queen & Co., Inc 4

Rand Drill Co. 47
Reliance Gauge Co. 59
Redfield, C. L. 21
Riter & Conley 72
Rochester Optical Co. 27
Roebling's Sons Co., John A. 50
Rogers & Co., C. B. 67
Ross Valve Co. 42

Scranton Supply & Mchy. Co. 24
Sellers & Co., Wm. 66
Sheffield Car Co. 7
Shawhan-Thresher Electric Co. 4
Sherwood Mfg. Co. 58
Smith, S. Morgan. 57
Smith Co., The H. B. 75
Southwark Foundry and Machine Co 64
Spinney, Virtue & Co 55
Spon & Chamberlain 23
Standard Electric Co. 7
Standard Mfg. Co. 70
Standard Paint Co. 34
Standard Tool Co. 66
Starrett, L. S. 69
Stearns Manufacturing Co. 61
Stevens Arms & Tool Co., J. 69
Stieren, Wm. E. 23
Stillwell-Bierce & Smith-Valle Co. 41
Stirling Co 3
Stow Flexible Shaft Co. 66
Stow Manufacturing Co. 65
Sturtevant Co., B. F. 74
Sullivan Machinery Co 48
Suplee, H. H. 23

Taylor Co., N. & G. 70
Toledo Machine and Tool Co. 69
Trenton Iron Co. 50
Triumph Electric Co. 57

Union Sewer Pipe Co. 43
United Electric Telephone Co. 57
U. S. Mineral Wool Co. 58
United States Heater Co. 75
Utica Pipe Foundry Co 43

Van Auken Steam Specialty Co. 54
Vandenbergh Laboratory of Chemical Industry. 22
Vanderbilt & Hopkins. 55
Vulcan Iron Works Co. 4

Walker Manufacturing Co. 40
Wanted and For Sale 24
Waterman Machine Tool Co. 66
Webber, Wm. O 22
West Shore R. R. 27
Westinghouse Air Brake Co. 53
Westinghouse Electric & Mfg. Co. 56
Westinghouse Machine Co 64
Weston Electrical Instrument Co. 39
Wetherill & Co., Robt. 25 & 63
Wheeling Corrugating Co. 73
Wheeler Condenser & Engineering Co. 60
Whitlock Coil Pipe Co 59
Wilkinson Co. 66
Wilks Mfg. Co. S 74
Williams Mfg. Co 32
Wilson Ear Drum Co. 7
Wingfield, Nisbet 21
Winslow Bros. Co 72
Wood & Co., R. D. 43
Worcester Machine Screw Co. 66
Wrought Iron Bridge Co. 72

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Advertising Experts.

Manufacturers' Advertising Bureau and Press Agency, New York..... 2

Architects.

Berlin Iron Bridge Co., East Berlin, Conn..... 114

Assayers.

Vandenbergh Laboratory of Chemical Industry, Buffalo, N. Y..... 22

Chemists.

Pittsburgh Testing Laboratory, Ltd. Pittsburgh, Pa..... 22
Vandenbergh Laboratory of Chemical Industry, Buffalo, N. Y..... 22

Civil Engineers.

E. L. Corthell..... 21
M. Fargusson, Southport, N. C..... 21
Wm. B. Fuller, Boston, Mass..... 22
E. S. Hussey..... 21
Alexander Potter New York and Pittsburg,..... 21
Webber, W. M. O..... 22
Nisbet Wingfield, Atlanta, Ga..... 21

Contracting Engineers.

Julian Kennedy, Pittsburgh, Pa..... 22

Electrical Engineers.

Alton D. Adams, Worcester, Mass..... 21
Wm. H. Bryan, St. Louis, Mo..... 21
A. L. McRae, Austin, Texas..... 21

Employment Bureaus.

Engineering Employment Bureau, Syracuse, N. Y..... 21

Mechanical Engineers.

D. Ashworth, Pittsburgh, Pa..... 21
Wm. H. Bryan, St. Louis..... 21
C. M. Conradson, Madison, Wis..... 21
Lewis K. Davis, New York..... 21
Julian Kennedy, Pittsburgh, Pa..... 22
Pittsburgh Testing Laboratory, Pittsburgh, Pa.. 22
C. L. Redfield, Chicago, Ill..... 21

Metallurgists.

Dr. Willis E. Everette, Tacoma, Wash..... 22
C. T. Gooding, Tucson, Arizona..... 22
Julian Kennedy, Pittsburgh, Pa..... 22
Frank Nicholson, Phœnix, Arizona..... 21
Pittsburgh Testing Laboratory, Pittsburgh, Pa. 22

Mining Engineers.

Lewis K. Davis, New York..... 21
Dr. Willis E. Everette, Tacoma, Wash..... 22
C. T. Gooding, Tucson, Arizona..... 22
E. P. Jennings, Ironwood, Mich..... 21
Frank Nicholson, Phœnix, Arizona..... 21

Sanitary Engineers.

Wm. B. Fuller, Boston, Mass..... 22
Alexander Potter, New York and Pittsburg..... 23

Schools.

Bliss School of Electricity, Washington, D. C... 23
Cheltenham Academy, Ogontz, Pa..... 23
Lawrence Scientific School, Cambridge, Mass... 23
Michigan Mining School, Houghton, Mich..... 23

Water Works Engineers.

Wm. H. Bryan, St. Louis..... 21
Lewis K. Davis, New York..... 22
M. Fargusson, Southport, N. C..... 21
Nisbet Wingfield, Atlanta, Ga..... 22

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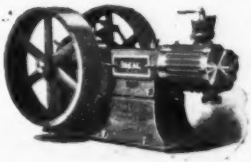

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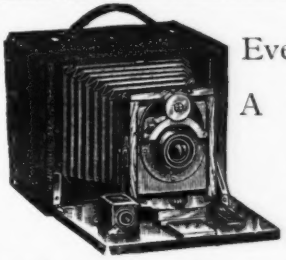

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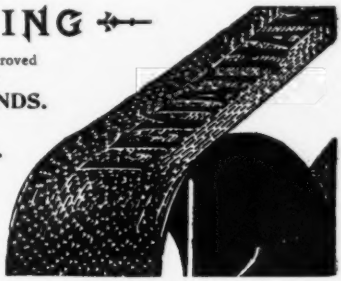

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The Rising Tide of Business Prosperity.

The sharp advance in the prices of all the great agricultural staples, the favorable crop reports from every quarter, the voluntary advance in wages throughout all lines of industry, the swelling volume of clearing-house exchanges, the steady increase in railroad earnings, the heavy purchases of American securities by foreign investors, the boom in the price of petroleum, and the complete recovery in that accepted barometer of trade, the iron market—these are all unmistakable evidences of a coming era of prosperity which will sweep away the last vestiges of the panic of 1893.

And not the least favorable feature of the outlook is the assurance of freedom from political agitations. With the Republicans in control of the House, the Populists holding the balance of power in the Senate, and a Democratic President in the White House, all partisan and radical legislation will be simply impossible. We shall have at least two years, and probably a much longer rest from all serious agitation of both the tariff and currency questions.

All of this makes cheerful reading—and the newspapers are full of it. It foretells a thriving business for all lines of industry, and it means competence and happiness for millions of people.

As for ourselves, THE ENGINEERING MAGAZINE'S share in the rising tide of business prosperity is very faithfully reflected by its cash book, as witness:—

HIRAM C. HORTON, Secretary and Business Manager of The Engineering Magazine Co., being first duly sworn, deposes and says that the books of the Company show that the aggregate cash receipts for subscriptions to THE ENGINEERING MAGAZINE during the six months ending June 30th, 1895, were just **sixty-one and five-sixths per cent. in excess** of the highest previous aggregate for any corresponding half year in the history of the Magazine; the said highest previous aggregate having been for the six months ending June, 1893, just previous to the panic.

(Signed) HIRAM C. HORTON.

Subscribed and sworn to before me this 6th day of July, 1895.
P. J. SCULLY,
Deputy Clerk, City and County of New York.

Never before have we added so large a number of *bona fide* new subscribers as during the past twelve months; never before the present time has the Magazine been read by so many thousands of intelligent, influential, and appreciative subscribers; and never before have our engagements of important special articles given larger promise of attracting an increasing number of interested readers. And since the world over a cash-paying subscription list, among numerous actual purchasers, is recognized as the very corner-stone and super-structure of a profitable advertising medium, it may be safely said that never before in its history have the Magazine's present and future been so full of promise as now.

In this connection it affords us pleasure to announce a further and very important improvement in the service rendered by our "Review of the Industrial Press."

Owing to the wide range covered by this Review and Index, and the heavy cost of its preparation and publication, we have heretofore given in the Index only the title, author, length, and date of publication of the leading articles appearing currently in the technical press. In addition, we shall hereafter give a few lines indicating the general character and purpose of each article, to the end that a reader may be able to judge very accurately as to whether or not he desires to see the full text of the publication.

The whole of this work will be done under the immediate personal supervision of professional engineers who are entirely competent to pass upon both the theoretical and practical value of all current technical literature, and thus every item in the Index will bear the stamp of expert professional approval. All that is of value will be carefully catalogued, but all that is worthless, trivial, or merely curious will be carefully excluded.

It is believed that this work will render a service of inestimable value to every branch of engineering science, and to the end that it may attain the highest possible degree of usefulness, we earnestly invite the freest criticism and suggestion from all who have occasion to use the Index.

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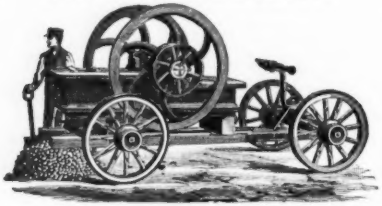
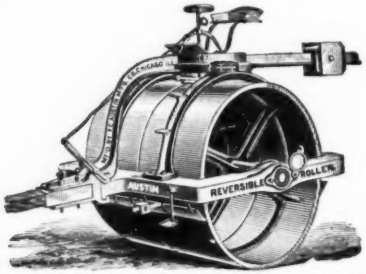


Austin Rock Crusher.—The jaws having compound oscillating movement, the crushing of rock is continuous. Embodies an entirely new principle whereby weight is reduced, capacity increased, less power required, and life of crusher prolonged. Awarded first medal at the World's Fair.



Austin Reversible Roller.—Has anti-friction roller bearings. No weight on horses necks. Is reversed or brake applied by driver without leaving his seat. Lightest draft and most easily handled. 1½ to 8 ton. Awarded first medal at the World's Fair.

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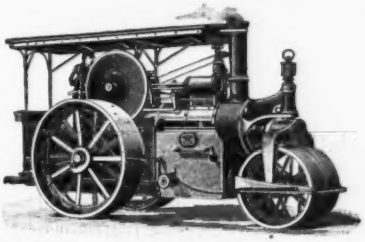

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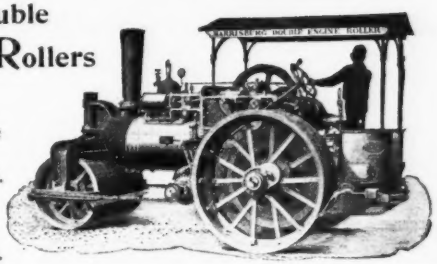

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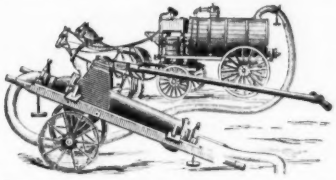

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WALTER L. DAVIS,
Owner of Mammoth Bar Gold Mine,
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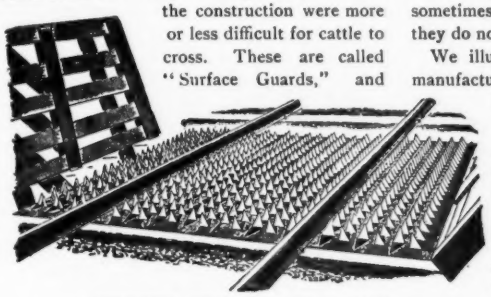
NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Sheffield Surface Cattle Guard.

FROM time immemorial it has been the custom for railroads to build pits at the points where roads cross their right of way, to keep cattle from straying thereon. These, however, were expensive to keep up, owing to decay of timbers, and made it difficult to keep the track from settling at such points. Within the past few years various appliances have been introduced in the nature of different arrangements of bars or rods of steel which could be laid upon the ground, and from the construction were more or less difficult for cattle to cross. These are called "Surface Guards," and have attained a large sale. It has been difficult, however, to find one which was impossible for stock to cross.



SHEFFIELD SURFACE CATTLE GUARD.

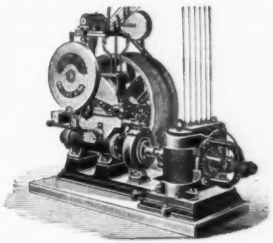
We illustrate herewith a new candidate for this line of work in the Sheffield Surface Cattle Guard, which certainly seems as if it were a device that would effectually prevent all kinds of stock from crossing, and be, therefore, the article which railroad men have been seeking. It is made of four sheets of annealed steel in which sharp teeth are struck up very close together all over the surface, presenting a seemingly impossible barrier to straying stock of all kinds. Another strong merit seems to be its simplicity, as there are no rods or bars to become broken or displaced, and no preparation of the track whatever is needed for it to be put in place.

This cattle guard is made by the Sheffield Car Company, Three Rivers, Michigan, U. S. A. and has already been adopted as their standard Guard by some leading roads.

The O'Donnell Electric Elevator.

THE electric elevator has proved almost as much of a success, in its way, as have any of the more popular applications of electricity. Electric elevators are cleanly, noiseless in action and do not diffuse heat in the buildings wherein they are used; they have no water pipes to freeze and sometimes burst with frost, and last, not least, they do not require a skilled attendant.

We illustrate herewith an electric elevator manufactured by M. J. O'Donnell and Co., Cleveland, Ohio, U. S. A. This machine requires a floor-space of only 4×6. The motor is so coupled to the elevator gear that it stops and starts with the winding machinery. This machine is equipped with an improved slack cable device and top and bottom automatic stop. The difficulties heretofore experienced from heating and burning out of the motor have been effectually guarded against in the construction of this machine. The switch and operating device is so constructed that the operator in the car can throw the electric contact to the same point with ease every time.



O'DONNELL ELECTRIC ELEVATOR.

It is asserted that these machines have been

in use for the past two years, costing practically nothing for repairs, and that it meets the full requirements of the mercantile houses, as it stops and starts easily.

Elevating and Convey.ng Specialties.

THE Jeffrey Manufacturing Co., Columbus, Ohio, U. S. A., is a pioneer house, in the manufacture of elevating and conveying machinery, and this establishment has erected numerous large and important installments. The accompanying engravings illustrate two of these installments. The experience of this company in this line of engineering extends over a period of 15 years. In the manufacture of these specialties they employ both standard and special chains, as well as their steel cable conveyors, which, with their accessories, are adapted for handling material of many kinds. Figure 1 is a stone-crushing plant, in which the Jeffrey bucket elevators carry the crushed stone from the breaker, delivering it into revolving screens overhead, from which it passes into storage bins. This plant is complete in every detail, and is one of many that we have installed.

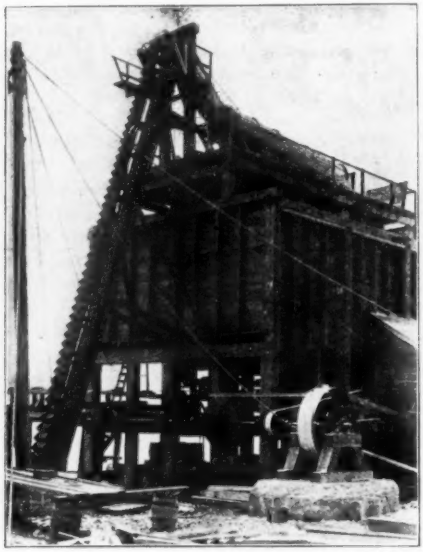


FIG. 1. COAL CRUSHING PLANT.

Figure 2 represents an installation of chain and cable conveyors at a large pulp mill. The chain conveyor in the foreground is 500 feet in length and conveys the pulp wood from the river to the steel cable conveyors located upon the trestle in the back-ground. The chain conveyor is arranged with spurs, while the cable conveyor is made up with conveying clamps. In this steel cable conveyor over 1,000 feet of cable are used. The storage capacity at the trestle is almost unlimited. The cable conveyor is arranged to carry the pulp wood to the storage ground and on its return conveys it back to the mill, when so desired. These outfits are comparatively inexpensive in the first cost, and are indispensable in large plants of this kind. A complete catalogue of the Jeffrey specialties can be had upon request, and inquiries will be cheerfully answered.

FIG. 2. CHAIN AND CABLE CONVEYOR.

A New Grease Cup.

WE illustrate herewith a new grease cup, which has recently been placed on the market by the Penberthy Injector Co., of Detroit, Mich., manufacturers of the "Penberthy" automatic injector. The name of this company is sufficient guarantee as to the quality of any new article which they may put on the market, but for this grease cup many points of superiority over anything of its kind now in use are claimed. The body is a glass cylinder, surrounded and protected by an outer brass shell with openings on four sides through which the user can tell at a glance the amount of grease or dope in the cup and know when to refill it, so that the journal where it is used never need be dry, unless through

carelessness. The plunger by which the grease is forced out from the bottom of the cup is made of a heavy rubber washer, protected on both sides by a brass disk, the whole being attached to the bottom of the stem in such a manner that the stem revolves without turning the washer or disks, and at the same time no grease can pass up through the centre of the washer. The cover never needs to be removed from the cup, as the body of the cup is screwed on to the shank and

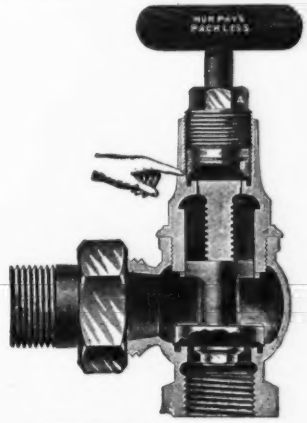
NEW GREASE CUP.

is removed from the shank to be refilled; therefore, there is no chance for any of the parts to be lost or mislaid when the cup is being filled. This cup is meeting with a very rapid sale, and while only placed on the market the first of January and advertised scarcely any since that time, the manufacturers say they have been unable to keep up with their orders and are somewhat behind even at the present time, although they started with a fair stock. Circular and price list of this cup will be sent on application to the manufacturers.

Murphy's Packless Valve.

THE radiator valve shown in the accompanying cut is now being placed on the market by Mr. C. P. Monash, Manager of the Van Auken Steam Specialty Co., of Chicago. The efficiency of this valve, as we are informed, has been thoroughly tested by parties who are experts in the steam engineering line, and it has proven entirely satisfactory. The improvement that this particular valve has, over other makes in the market, will be noticed by a glance at the cut. A lengthy description is therefore not necessary.

The disc lettered *B* in the neck of the valve does the work. It saves the annoyance of escap-



MURPHY'S PACKLESS VALVE.

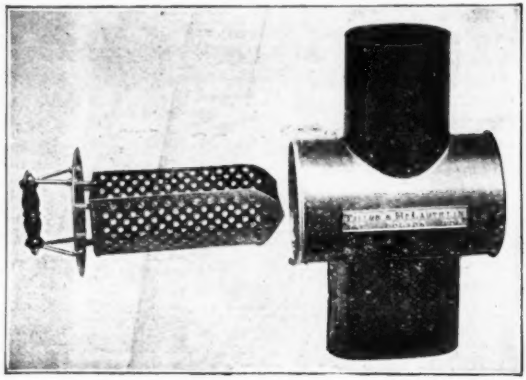
ing steam, water, air, or gas, and is so guaranteed. The nut lettered *A* is used for adjusting the disc *B*. The value of a packless valve will be comprehended and appreciated by those readers of this journal who have use for valves.

The valves are made for both high and low pressure, in globe, angle, and straight-way styles. The material and workmanship used in the construction of this valve are claimed to be first-class in every respect. Parties who would like to see a valve that has no packing, will not leak, and gives no trouble and expense, should address Mr. Monash, for further information.

A Household Garbage Carbonizer.

THE complete removal of and ready disposal of domestic garbage in a simple and inexpensive manner, is the object of the improvement represented in the accompanying illustration, which device is being introduced by the Sanitary Construction Co., of No. 113 Devonshire street, Boston, Mass. The carbonizer consists of a horizontal cylinder about one-third larger in diameter than the stove pipe, in which it is to be placed according to convenience, in a joint or an elbow of the pipe making the connection between the stove and the chimney. It may be applied to any stove or furnace and any size of pipe. One end of the cylinder is removable, and attached thereto is a basket or scoop of somewhat reduced diameter, with perforated sides and a tight bottom, affording free passage for the smoke and heat from the stove around the scoop and through the

perforations. When this scoop or basket is filled with garbage and placed in the cylinder, the water is quickly driven off and the residuum changed to charcoal, which burns freely when placed in the fire, affording in fact a valuable material for kindling the fire in the morning. The natural draft up the chimney prevents the escape of any odor into the rooms and there is no odor from the chimney as the gases from the stove thoroughly deodorize the gases from the drying garbage. It is intended that the waste shall be placed in the carbonizer as it is made, so that there will be no accumulating garbage in the kitchen, and no need of a garbage bucket.



GARBAGE CARBONIZER.

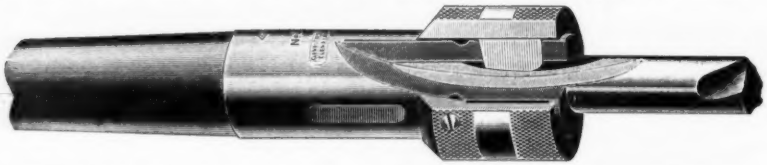
We are informed that the device has been highly recommended by the chairman of the Boston Health Board and other sanitary and street cleaning officials, and that many of them are in use in Boston and vicinity. Messrs. W. F. Moore & Co., New York, are agents for this devise.

Twist Drill Grip Socket.

THIS Grip Socket is designed to hold and drive taper shank drills and other tools. A groove, which is an arc of a true circle, is milled in the shank of the drill or tool—as shown in the sectional illustration, and key let into the body of the socket fits into the groove, and is *locked* securely in place by a turn of the revolving internally eccentrically counterbored collar. After the key is locked, it is impossible for the tool to slip in the socket or to be pulled out, until the collar is turned back again to release the key. The end of the collar is beveled, and a plain index mark on it and on the body of the socket shows when the key is released.

Drills or tools that have had the tangs on the shanks twisted off can be used in these Grip Sockets successfully, and in this way the cost of the sockets can be saved many times annually. Boring bars for under cutting can be used with out any danger of their pulling out of the sockets, and the labor and expense of turning over heavy pieces saved. This excellent device, the advantages of which are very apparent, is manufactured by the Cleveland Twist Drill Co., Cleveland, Ohio, U. S. A., whose line of drills is also winning continually a wider favor and patronage.

TWIST DRILL GRIP-SOCKET READY FOR USE.



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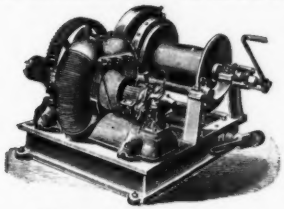

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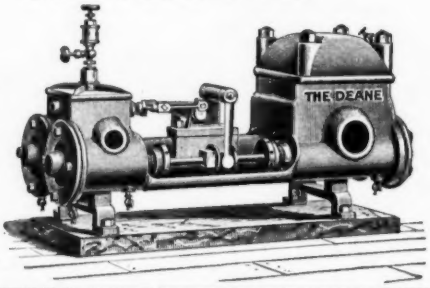

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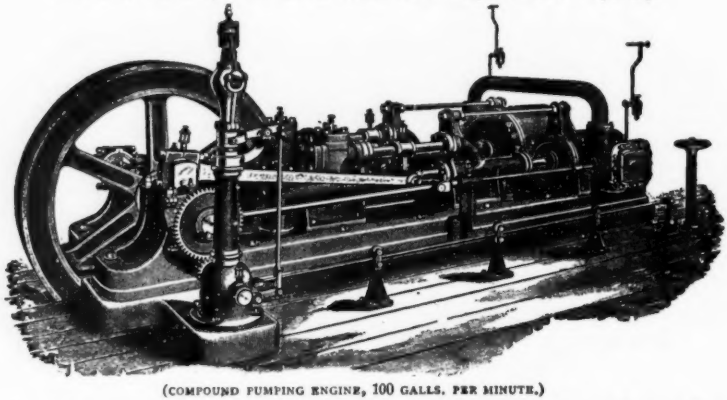

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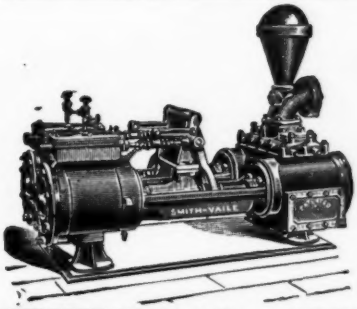

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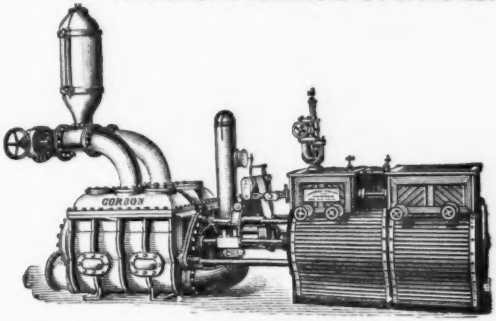

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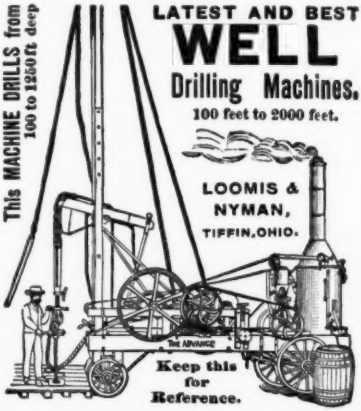

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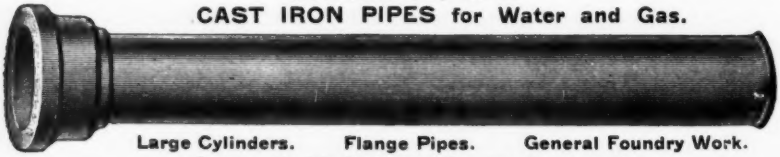

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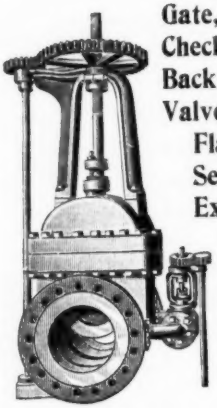

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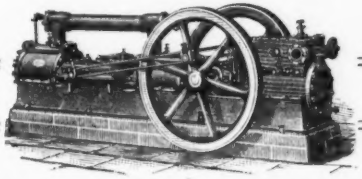

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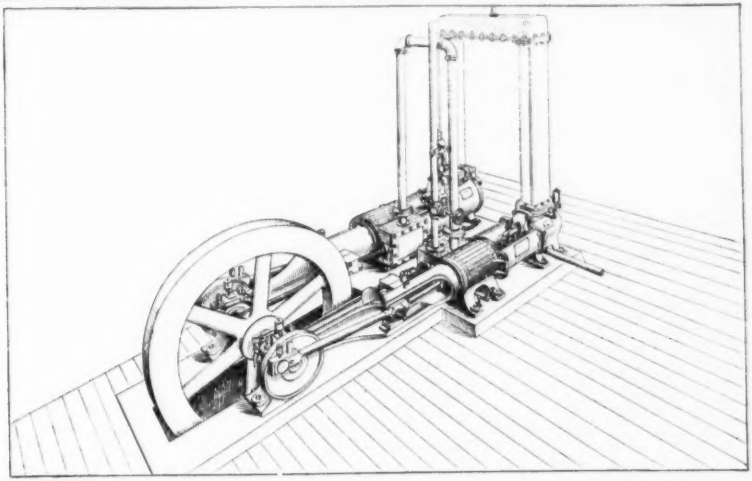

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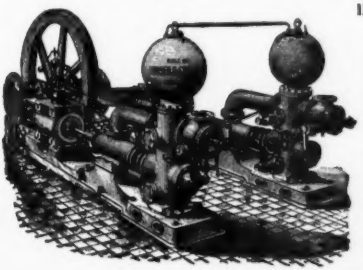

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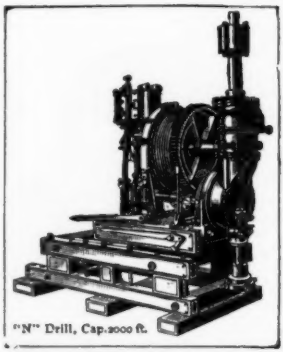

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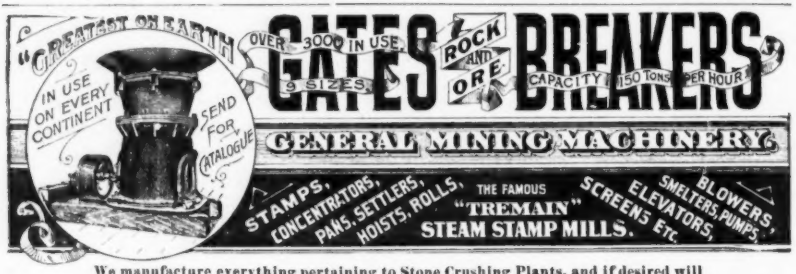

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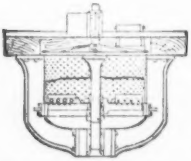

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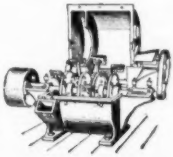

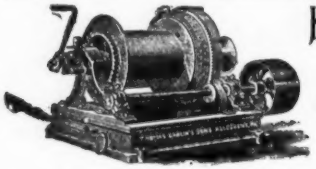

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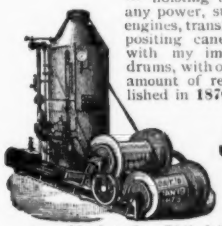

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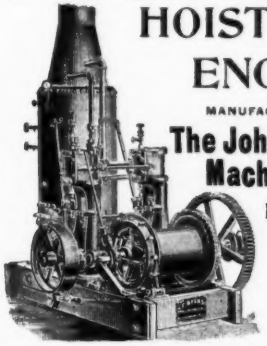

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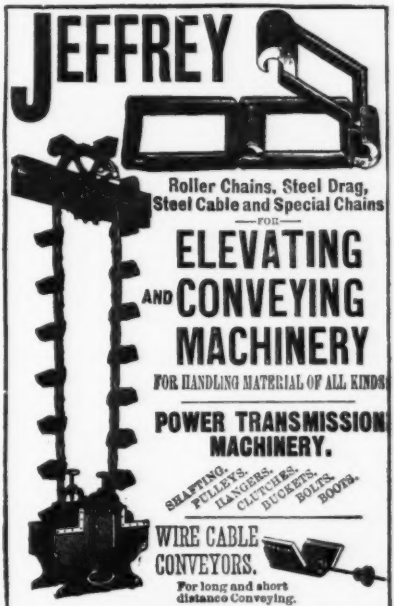

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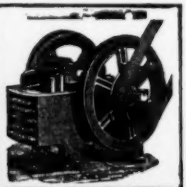

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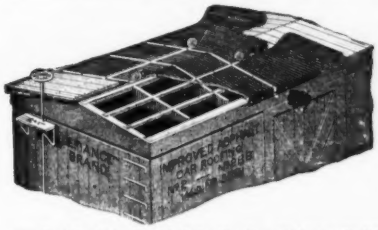

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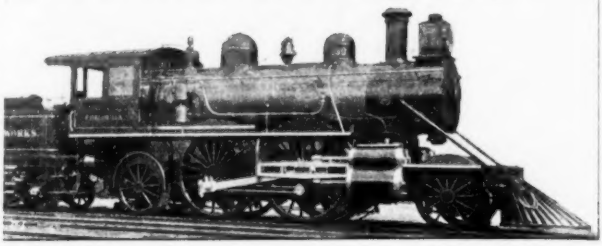

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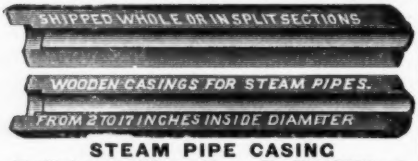

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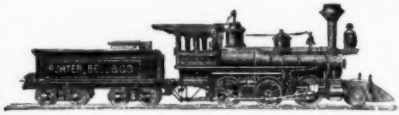

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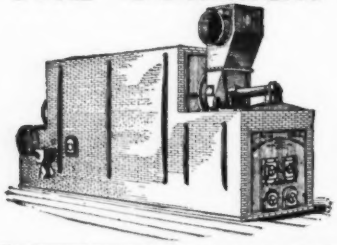

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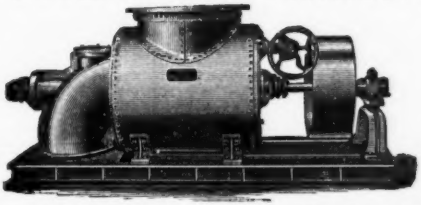

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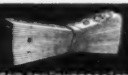

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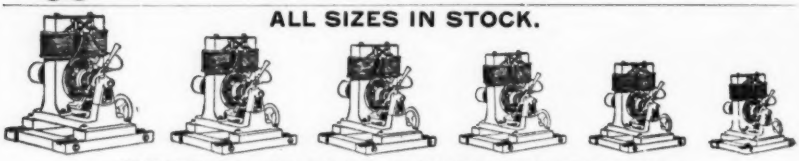

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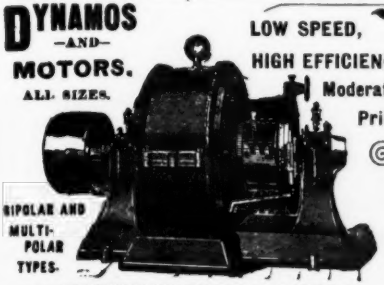

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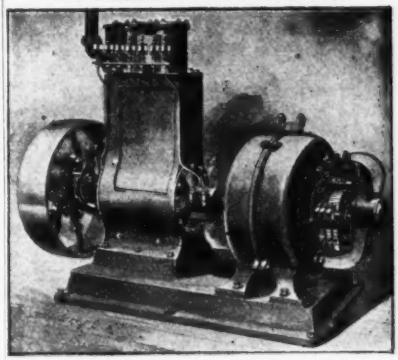

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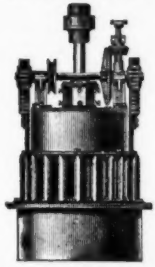

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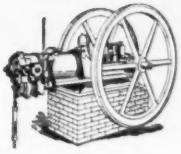

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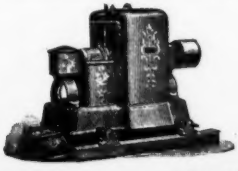

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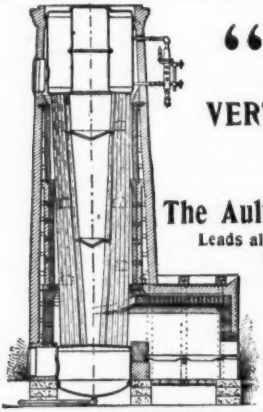

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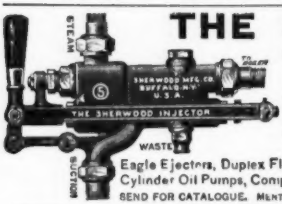

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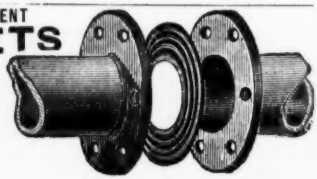

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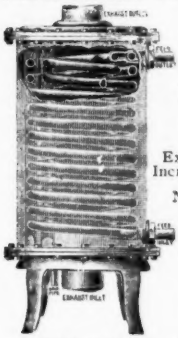

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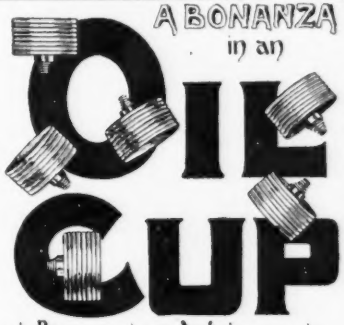

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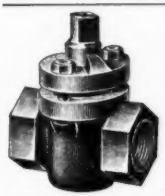

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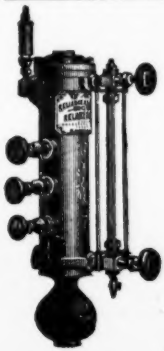

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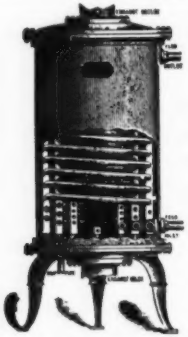

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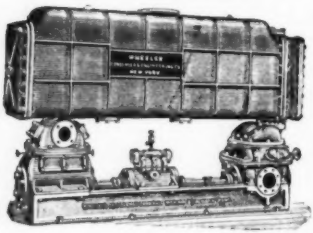

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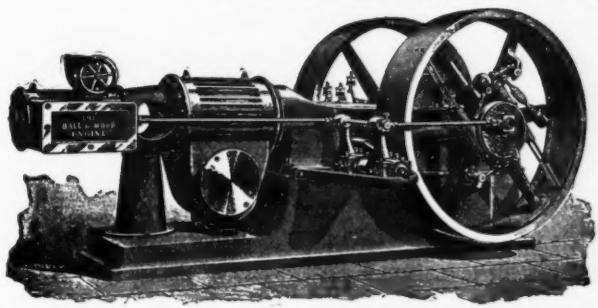

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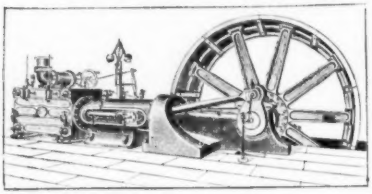

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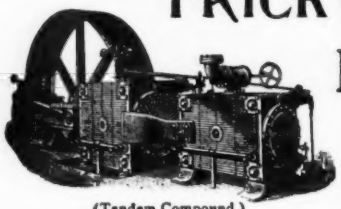

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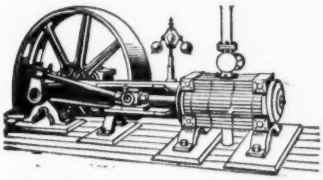

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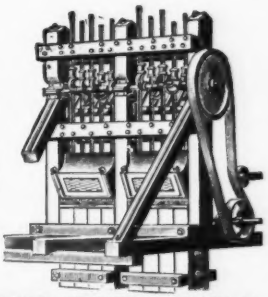

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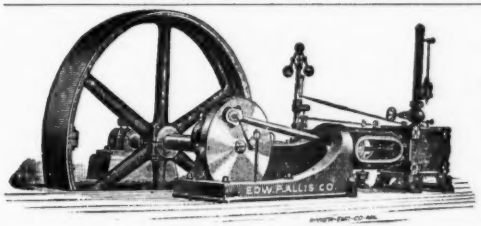

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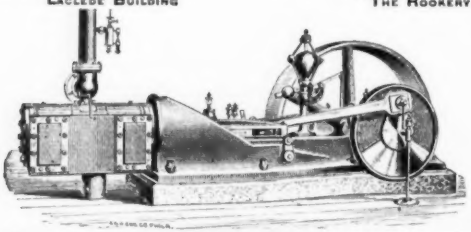

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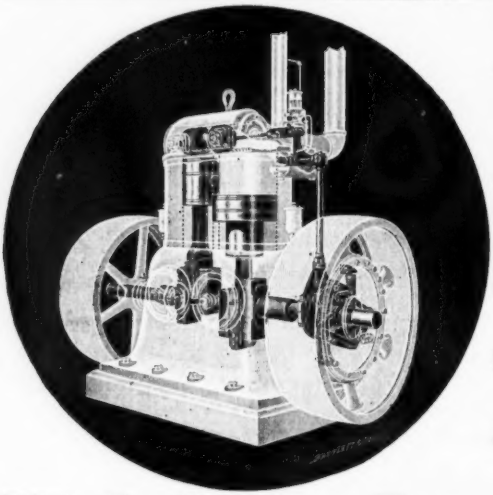

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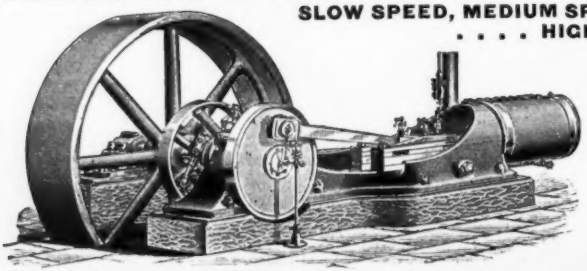

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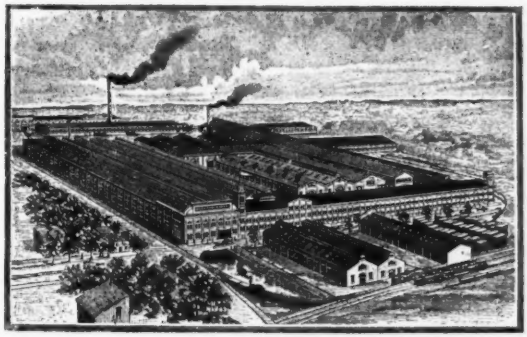

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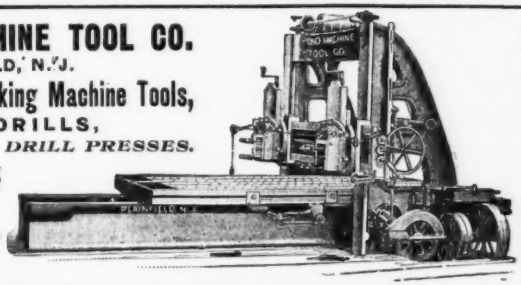

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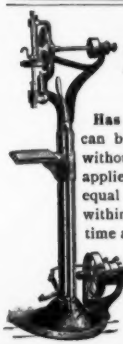

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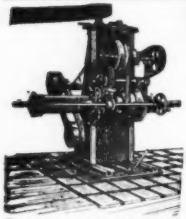

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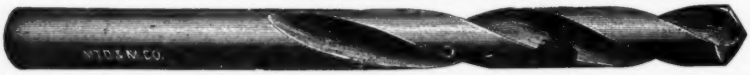

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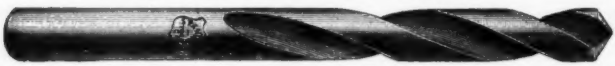

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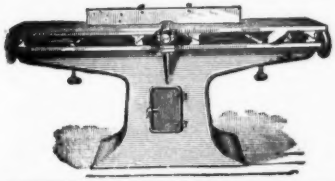

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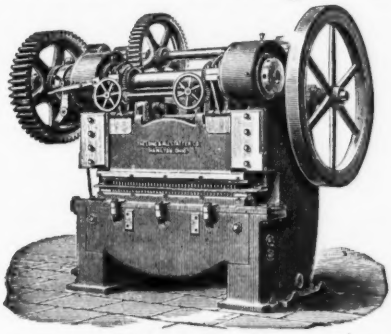

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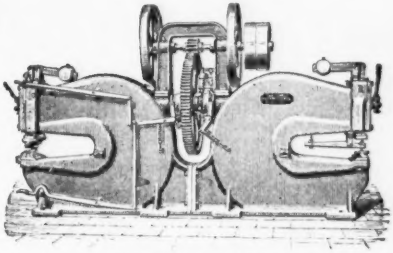

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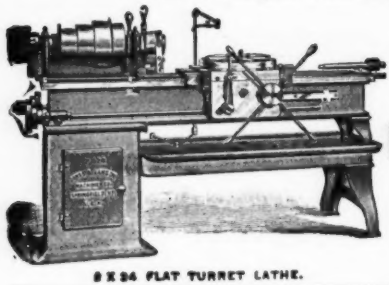

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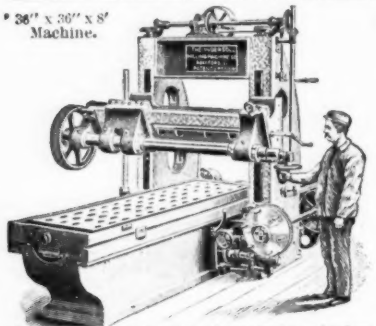

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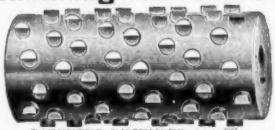

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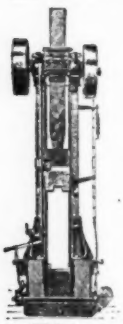

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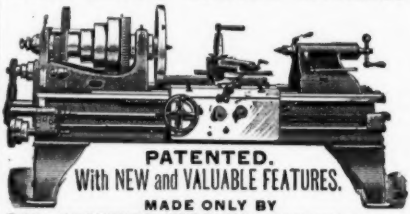

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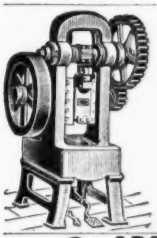

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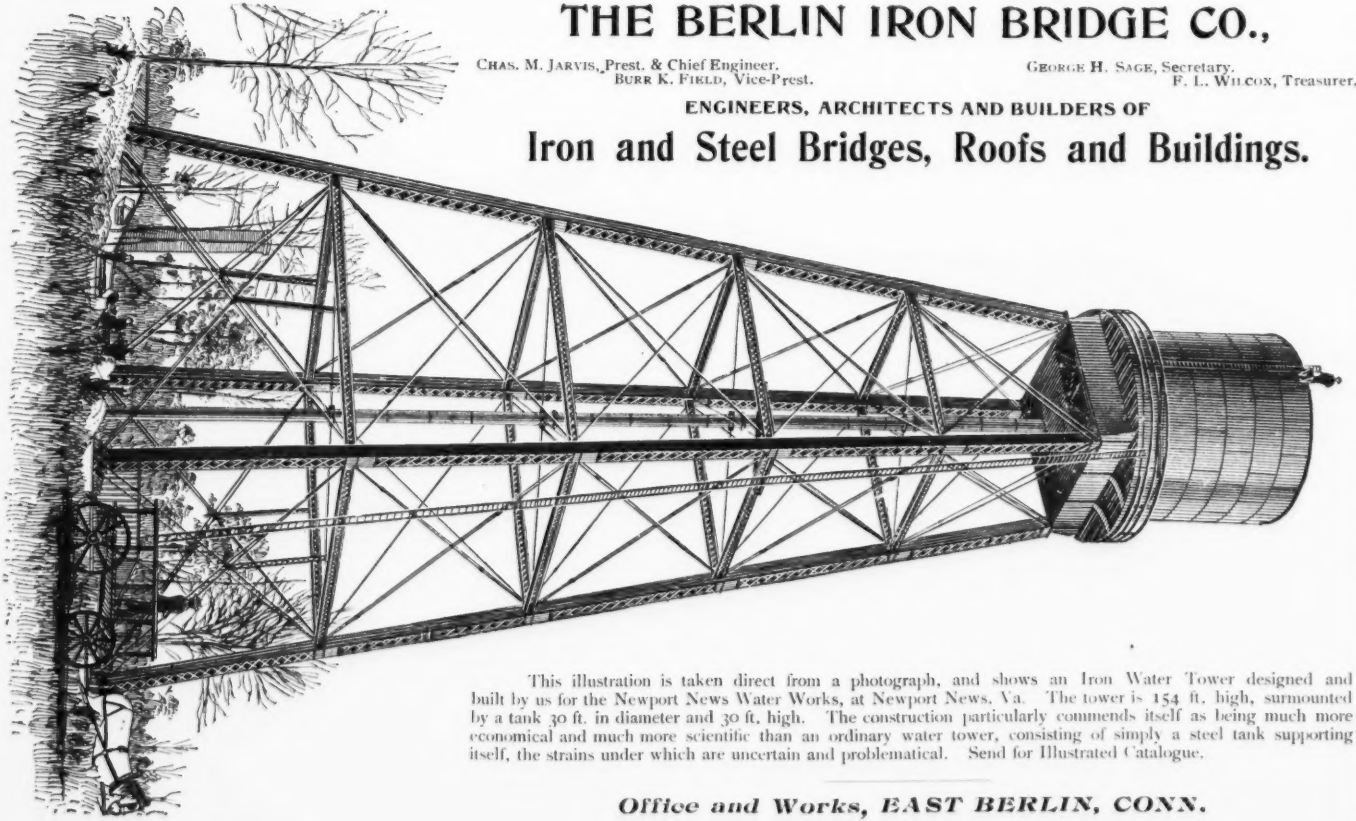

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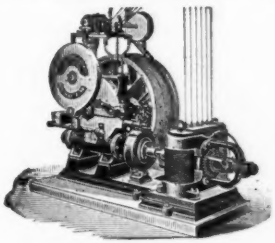
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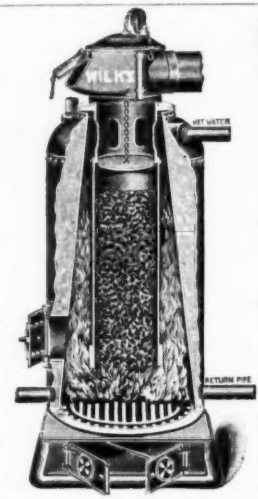

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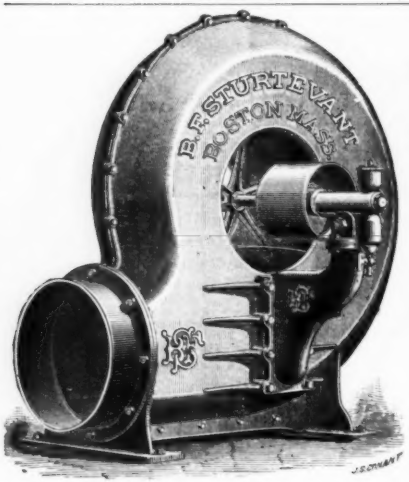

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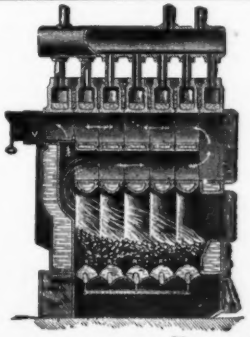

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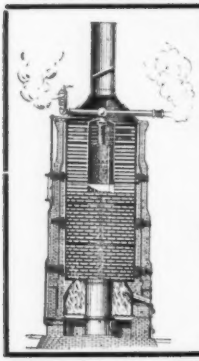

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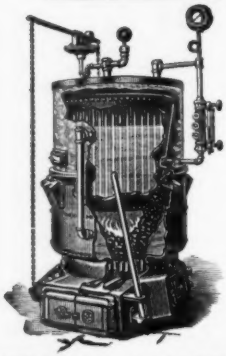

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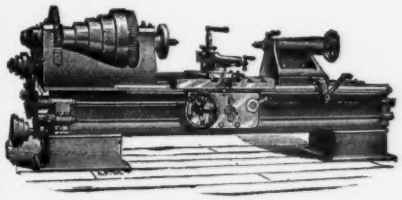

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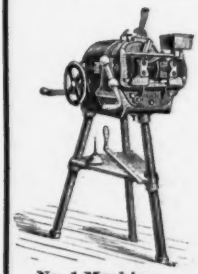

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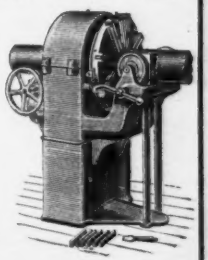

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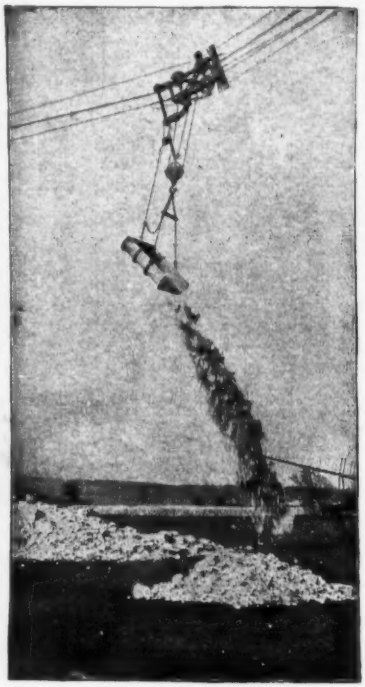

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